A SUMMARY REPORT ON THE EFFECTS OF DREDGING, DREDGED SPOILS DISPOSAL AND LAKEFILLING ACTIVITIES ON WATER QUALITY IN THE TORONTO WATERFRONT AUGUST 15 - NOVEMBER 29, 1980

November, 1981

Ontario

Ministry
of the
Environment

The Honourable
Keith C. Norton, Q.C.,
Minister

Gérard J. M. Raymond
Deputy Minister

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by

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EXECUTIVE SUMMARY

A study conducted in an area of the Toronto waterfront between the Toronto Island and R.C. Harris water filtration plant intakes found that water quality effects of dredging at the Don River mouth, dredged spoils disposal in an endikement and lakefilling activities using excavated trucked fill at the Headland (Fig. 1) were localized and no evidence was found to suggest that these activities adversely affected the Toronto water supplies. Major findings of this study are presented below.

1. Effects of Dredging on Water Quality

   Dredging at the Don River mouth resulted in an increase of turbidity and suspended solid levels in the immediate area of the activity and occasionally in the Inner Harbour. During dredging, suspended solid levels rose from a predredging mean of 25 mg/L to a mean of 123 mg/L. (Waters normally containing from 80 to 400 mg/L suspended solids are unlikely to support good freshwater fisheries.) Dredging appeared to be responsible for increasing overall levels of the pesticide lindane, and metals including lead, copper, chromium and zinc in the water at the mouth of the Don River. Furthermore, levels in excess of Provincial Water Quality Objectives established for the protection of aquatic life, were recorded for lindane, zinc, lead and copper. These effects of dredging were largely confined to the immediate area of the activity and did not affect the concentrations elsewhere along the waterfront. Dredging did not significantly elevate concentrations of nutrients, or PCBs in the water adjacent to the dredging activity.

2. Effects of Dredged Spoils Disposal on Water Quality

   During the dredged spoils disposal period, significant increases in the levels of turbidity and suspended solids were recorded in the gap of the disposal endikement located at the Headland.

Small, but statistically significant increases in conductivity, alkalinity, and lead recorded in the gap during dredged spoils disposal suggest that some loss of material from the embayment was taking place. This loss did not result in any levels exceeding the Provincial Water Quality Objectives at the embayment gap and is not believed to be of environmental significance.

3. Effects of Lakefilling on Water Quality

Headland lakefill construction (using excavated trucked fill) contributed to plumes of elevated turbidity which varied in size from localized plumes (less than 500 m radius) formed under low winds (less than 20 km/hr) to more extensive plumes (greater than 2 km long, 500 m wide) formed under high wind (greater than 20 km/hr) conditions. Storm conditions (winds greater than 30 km/hr) that did not permit lake sampling, likely caused more extensive plumes than those observed. Turbidity levels of 10 FTU's or greater were not uncommon in the immediate vicinity of the fill site and were surpassed in magnitude only by levels measured at the dredge site located near the mouth of the Don River. Average suspended solid concentrations in the immediate vicinity of the fill site during the study period was 11 mg/L, a number well below the 80 mg/L level considered unlikely to support good freshwater fisheries. The lakefilling activity did not contribute significantly to increases of nutrient, PCB, organochlorine pesticide or metal levels in the water.

4. Drinking Water Quality

Drinking water distributed by the R.C. Harris and Toronto Island water filtration plants was found to be in compliance at all times with the revised 1981 Ontario Drinking Water Quality Objectives (soon to be published). There was also no evidence to suggest that either the dredging, dredged spoils disposal or lakefilling activities affected the quality of drinking water distributed by the plants.

Although PCBs were detected in the drinking water on three out of forty-four occasions, even the highest recorded value (0.080 μg/L) was considerably below the 3 μg/L interim Ontario Drinking Water Quality Objective, based on long-term consumption. Minute quantities of seven pesticides including lindane, α BHC and β BHC, were found in the drinking water in concentrations several orders of magnitude lower than the revised Ontario Drinking Water Quality Objectives. At no time did the total measured pesticide level in finished water exceed or approach the 0.1 mg/L (100 μg/L) revised Ontario Drinking Water Objective. Trace metal levels were also at or near detection levels and never exceeded the revised Ontario Drinking Water Quality Objectives. It has been shown in separate studies that trihalomethanes and other volatile organics in the drinking water have been also consistently in compliance with the revised Ontario Drinking Water Objectives.

5. Quality of Dredged Spoils

Sediments dredged from the Don River mouth, west of the Cherry Street bridge, did not meet MOE open water disposal guidelines for oils and greases, total phosphorus, PCBs and heavy metals such as lead, zinc and cadmium. These results confirmed previous Ministry data on Don River mouth and Keating Channel sediment quality which led to the Ministry's identification of the need for contained disposal of Keating Channel sediments and the decision to require confinement in dredged spoils disposal embayments located at the Headland.

6. Quality of Trucked Fill Material

Trucked fill material used in the construction of the Headland was found to have levels of several metals including mercury, lead and copper, both higher than background (erodable bluff material), and in excess of the MOE open water disposal guidelines especially in fill originating from Front Street excavation sites. Iron and chromium levels were also in excess of the

guidelines but were consistent among the excavation sites. Trace amounts of several organochlorine pesticides were also present in some fill samples. Even though the trucked fill material was deposited almost continuously on the Headland during the study period, the monitoring program showed that levels in the adjoining waters met the Provincial Water Quality Objectives.

I INTRODUCTION

In 1980, the Great Lakes Surveys Unit of the Ontario Ministry of the Environment (MOE) initiated a study of the Toronto waterfront aimed at assessing the water quality impacts of dredging the Don River mouth, disposal of dredged spoils into a semi-confined embayment located at the Headland and lakefilling at the Headland using excavated trucked fill. Detailed discussion of these activities is presented in Section III of this report.

This study was primarily designed to examine immediate impacts of these activities on water quality as it relates to aquatic life, water supply and recreation. Assessment of long term effects was beyond the scope of this investigation. This monitoring program was one of several carried out in the Toronto waterfront area by various government agencies.

The study included:

1) investigating the relative inputs of nutrients, bacteria, metals, organochlorine compounds and associated parameters from such potential sources as dredging, dredged spoils disposal activities, and the Headland construction;

2) comparing the spatial and temporal variability of water quality close to potential sources and the construction sites and along the waterfront before and during dredging;

3) monitoring the raw and finished waters at the R.C. Harris and Toronto Island filtration plants before and during dredging.

This report updates information presented in an earlier publication entitled "Effects of Keating Channel Dredge Spoil Disposal and Landfilling at the Headland on the Water Quality in the Toronto Waterfront, May 15 - August 15, 1980". Data presented and discussed in the present summary report span the period of August 15 to November 29, 1980. A complete data set of all results generated by this study is available upon request.

II DESCRIPTION OF STUDY AREA, SURVEY DESIGN AND DATA ANALYSIS

(i) Study Area

The area under study extends from the Toronto Island filtration plant intake in the west to the R.C. Harris filtration plant intake in the east and encompasses the Toronto Inner and Outer Harbours and an area off the Headland (Fig. 1).

The Toronto Inner Harbour receives inputs from the Don River and a number of storm and combined sewer overflows. The only direct input into the Toronto Outer Harbour is the cooling water discharge from the R.L. Hearn generating station. Water exchange between the Inner Harbour, Outer Harbour and Lake Ontario takes place through the eastern and western gaps and the discharge from the generating station. A net inflow of water to the harbour normally occurs through the western gap and a net outflow through the eastern gap. The Toronto Main sewage treatment plant (STP) discharge represents a major contaminant input to L. Ontario in the area northeast of the Headland.

(ii) Survey Design

Water

This study covers a predredging period of August 15 - October 15 and a dredging period of October 16 - November 29, 1980. Water quality sampling was carried out at 22 stations (Fig. 1) every Tuesday and Thursday, weather permitting, or the next possible day until November 29, 1980 when inclement weather necessitated termination of the study. The dredging of the Don River mouth and nearby slips continued until December 11, 1980.

Sampling at the R.C. Harris water filtration plant was conducted on a daily basis, (Monday to Friday) beginning on September 30, 1980. A similar sampling program was carried out at the Toronto Island water filtration plant up until the time of its closure in late August (the Toronto Island plant is generally in operation only during summer peak demand periods and was closed

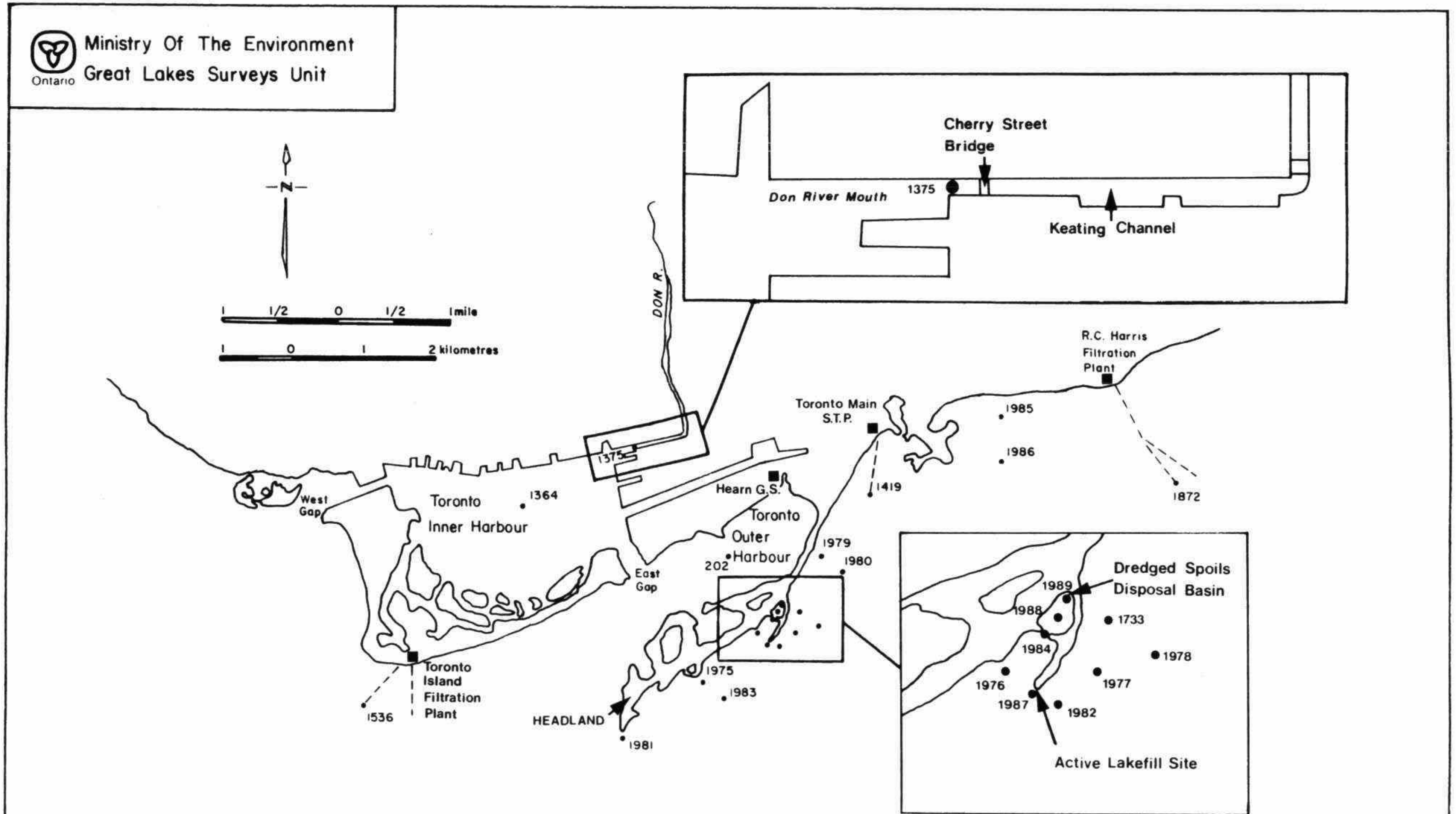

FIGURE 1:
STATION LOCATIONS

throughout most of the study period). Samples of raw and finished water were collected at the plants by personnel from the Municipality of Metropolitan Toronto Department of Works (Metro Works). The average plant retention time was allowed for by staggering the sampling of raw and finished water by 4 hours. This provided some assurance, but no guarantee, that the "batch" of finished water sampled in the afternoon was correlated to the raw water sampled in the morning.

Each of the 22 stations was sampled for turbidity, suspended solids and conductivity at the surface (1.5 m.), at 5 m. and at 2 m. from the bottom. In addition, surface water samples from eight key waterfront locations and from the filtration plants were analyzed for nutrients, metals, PCBs, mirex, organochlorine pesticides, bacteria and associated parameters. The occurrence of volatile organics including trihalomethanes in drinking water was investigated both by Metro Works and MOE in separate studies. Continuous turbidity determinations of raw and finished R.C. Harris water were made at the plant by Metro Works' staff. Average daily results based on these measurements were used in this report. Samples from the remaining stations were analyzed primarily for turbidity, suspended solids and conductivity. With the exception of R.C. Harris water turbidity determinations, all analyses were carried out at the MOE laboratory.

Trucked Fill

The excavated trucked fill material used in the construction of the Headland was sampled on two occasions (August 1 and August 26, 1980) by the Environmental Protection Service of Environment Canada and analysed by MOE laboratories. This program was set up to detect the presence of any contaminants which could potentially be lost through lakefill erosion into the water column.

Sediments

A sediment core sample from the mouth of the Don River was collected in the fall of 1980 by MOE using a split-spoon corer

which penetrated the sediments down to the hard bottom of the river (approximately 3 m depth). The sediment core was retrieved without flushing in order to minimize the loss of fine sediments. Surface sediments (top 3 cm) were also sampled (in triplicate) with a Ponar grab to evaluate contamination in the uppermost layer of the sediments which were in contact with the water. All sediment analyses were carried out at the MOE laboratories.

(iii) Data Analysis

Water quality data collected during this study were summarized graphically by comparing conditions prior to dredging with those during the dredging period. Wherever applicable, water quality results were compared to the Provincial Water Quality Objectives (PWQO). In instances where the analytical detection limits were higher than the PWQO (e.g., PCBs), only quantifiable numbers (i.e., those at or above detection) can be said to exceed the PWQO with certainty In the summary figures and tables, wherever possible, mean (average) values were used. In cases where results below the MOE laboratory levels of detection were found, a range of means was employed. This range encompasses all the possible mean values for a data set containing one or more results less than the detection limit. An example showing range of mean derivation is given below.

Assume a data set consisting of the following results: <20, 30, 40 where the detection limit is 20.

The lower range of the mean is calculated assuming that all less than detection values equal zero and thus the data set becomes 0, 30, 40 with a mean of 23.

The upper range of the mean is calculated assuming that all less than detection values are at the detection limit, and thus, the data set becomes 20, 30, 40 with a mean of 30.

Thus the range of means for this given data set is 23-30.

III HEADLAND CONSTRUCTION, DREDGING AND DREDGED SPOILS DISPOSAL ACTIVITIES

(i) Dredging and Dredged Spoils Disposal

No routine dredging of the Keating Channel (that part of the Don River east of the Cherry Street bridge and west of the river bend, Fig. 1) has taken place since 1974. Based on past analysis of Keating Channel sediments, MOE concluded that only contained disposal of this material was acceptable. Subsequently, in 1979, it was agreed that an endikement with a narrow gap (62 m.) and a sill was an adequate containment for these sediments subject to consideration of several factors pertaining to the construction and stability of the containment structure.

In the summer and fall of 1980, emergency dredging west of the Cherry Street bridge and in slips located along the north-eastern corner of the Toronto Inner Harbour was carried out for navigational purposes by the Toronto Harbour Commission (T.H.C.) using a clam shell derrick. The dredgeate was loaded into bottom dump scows which were towed to the most northerly portion of the first endikement and unloaded by opening the bottom doors while pushing the scow up onto previously dumped material. This dredging was carried out intermittently between May 20 and June 20 and resumed again on October 16, to end in mid-December, 1980.

Between October 16 and November 29, 1980 an estimated total of 24,000 m^3 of dredged sands, silts and clays were deposited inside the first endikement and an estimated total of 140,000 m^3 of trucked fill were used in an adjacent area for the expansion of the Headland. Throughout 1980, a total volume of 43,000 m^3 of dredged spoils and 1,041,000 m^3 of trucked fill material was placed on the Headland (based on T.H.C. operating report summaries).

(ii) Headland Construction

The Toronto Harbour Commission began the construction of the Headland, also known as the Leslie St. Spit, in the late 1950's. To date, over 16 million cubic meters of trucked fill and dredged material have been used to construct the Headland, 160 hectares in area, and extending approximately 5 kilometres into Lake Ontario. Construction activities are continuing and have now entered a phase of shoreline re-alignment with the construction of a series of basins or endikements along the Headland's southeastern side.

During the August-November 1980 study period active lakefilling was taking place only on the southern side of the Headland at the site of the dredged spoils disposal endikements (Fig. 2).

By July, the first endikement was virtually finished and during the course of this survey (August - November) an approximate volume of 325,000 m^3 of trucked fill material composed of earth, clay, shale and fine sand was used to begin the second dredgeate basin. In addition, approximately 60,000 m^3 of coarser material (concrete slab, gravel, brick rubble, broken asphalt, larger concrete blocks and stone) were used to reinforce the structure and minimize losses due to erosion. Construction at the site is continuing. Construction details are described in a Toronto Harbour Commission's report published in December 1980 and entitled "Operating Procedures, Waste Disposal Site at South Side of Leslie St. Spit".

Despite existing efforts by THC to control erosion through selective placement of material at the lakefill site (mixing and protection), loss of fill material into the adjacent water was observed especially during stormy periods.

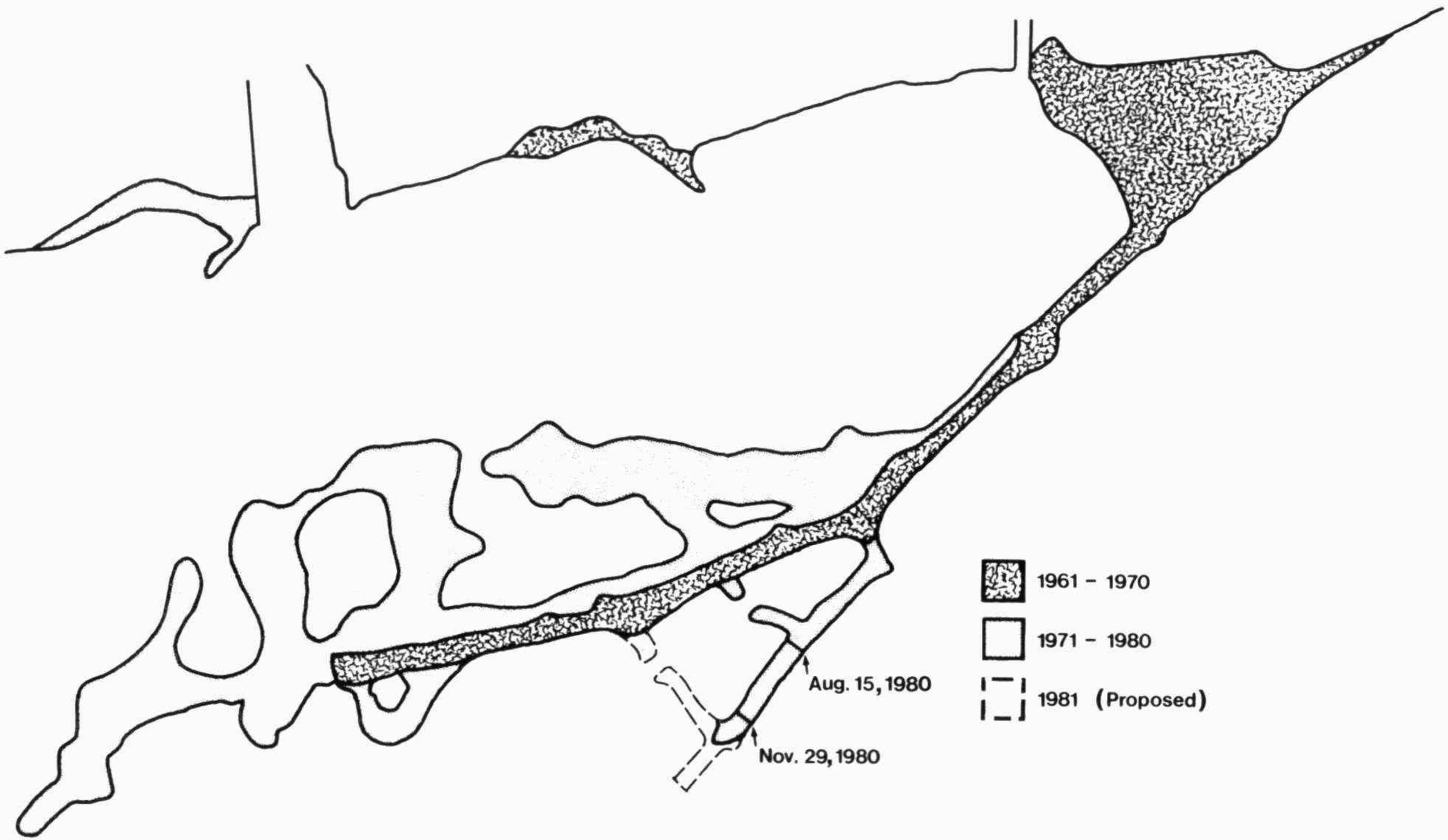

FIGURE 2: HEADLAND CONSTRUCTION 1961 - 1981

IV QUALITY OF TRUCKED FILL AND DREDGED SPOILS

(i) Dredged Spoils

Previous Ministry studies have found that sediment quality in the Keating Channel/Don River mouth area exhibits an east-west gradient with the worst quality being found in its western section (Wilkins[1]). Results of the 1980 sediment sampling (carried out just west of the Cherry Street bridge) must be placed in context of the east-west gradient. Generally, it can be assumed that sediment quality west of the core sampling site is more degraded than that east of the core site.

Results of deep core sampling of sediments west of the Cherry St. bridge revealed that they are not suitable for open water disposal since they exceed the MOE open water disposal guidelines for oils and greases, PCBs and several heavy metals such as lead, zinc and cadmium. These results confirmed previous Ministry data on Don River mouth and Keating Channel sediment quality which led to the Ministry's identification of the need for contained disposal of Keating Channel sediments and the decision to require their confinement in dredged spoils disposal embayments located at the Headland.

(ii) Trucked Fill

The Environmental Protection Service of Environment Canada, on August 1 and 26, 1980, sampled a number of trucks arriving from major excavation sites in Toronto. Although the information collected through this sampling program did not characterize the quality of all fill reaching the Headland, it did provide an indication of potential contamination problems.

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1 Wilkins, W.D., 1974. Sediment Quality on the Toronto Waterfront. MOE, pp8.

Comparisons of excavated soils can be made in relation to MOE open water disposal guidelines and to known background concentrations, which, for purposes of this report, will refer to erodable bluff material levels reported by Thomas and Haras[1]. Based on these comparisons, iron and chromium levels, which were consistent among the sites, exceeded the MOE guidelines, although they were comparable to levels found in erodable bluff material. Of greater significance was the occurrence of mercury, lead and copper in levels in excess both of the MOE guidelines and background levels especially in trucks originating from Front Street excavation sites. It is important to note here that even though this trucked fill material was almost continuously deposited on the Headland during the study period, the monitoring program showed that levels in the adjoining waters met the Provincial Water Quality Objectives.

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1 Thomas R.L. and W.S.Haras, 1978. Contribution of sediment and associated elements to the Great Lakes from erosion of the Canadian shoreline. PLUARG Tech. Rep. Task D., Activity 1. IJC. pp57.

V WATER QUALITY ALONG THE TORONTO WATERFRONT PRIOR TO AND DURING DREDGING

The Provincial Water Quality Objectives (PWQO) established for the protection of aquatic life and recreation were used in assessing the quality of all water samples collected with the exception of drinking water in which case the revised Ontario Drinking Water Objectives were used. The PWQO appear in the publication entitled "Water Management Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment, November 1978".

(i) Turbidity and Suspended Solids

Turbidity and suspended solids are tracers which can be used to assess the movement and effect of excavated materials or dredged sediments deposited into the aquatic environment. Impact assessment based on these parameters is complicated by the inherent variability caused by the resuspension of bottom sediments by wave action, erosion of the adjacent shoreline, and inputs from other sources such as rivers, sewage treatment plants and sewers. For example, turbidity levels near the Headland are influenced not only by the lakefilling and dredged spoils disposal operations, but also by the Toronto Main STP effluent, erosion from the existing land forms and sediment load carried from the Scarborough Bluffs. The interpretation of turbidity plumes near the Headland is further complicated by the very close proximity of the lakefilling site to the dredged spoils disposal site, a situation which makes it difficult to accurately quantitatively assess the relative contribution of these two activities to turbidity levels in the area.

Turbidity levels along the Toronto waterfront between the R.C. Harris and Toronto Island filtration plant intakes were sampled along a grid of 22 stations (Fig. 1). This grid was established primarily to assess the effects of lakefilling and dredged spoils disposal activities on the receiving waters. Turbidity

levels were also measured in the immediate vicinity of the dredging site at the outlet of the Keating Channel. Turbidity plumes for a range of weather conditions prior to dredging (August 15 - October 15) and during dredging (October 16 - November 29) are presented in Figs. 3-6. A comparison of turbidity and suspended solid levels before and during dredging at 8 key locations is made in Figs. 7 and 8.

The turbidity levels within the plume emanating from the lakefill/spoils disposal sites were often higher than those recorded in the Toronto Inner and Outer Harbours. Levels of 10 FTUs or greater were not uncommon in the immediate vicinity of the fill site and were surpassed in magnitude only by turbidities measured at the active dredging site.

The turbidity patterns associated with the lakefill/spoils disposal activities varied from largely localized plumes (less than 500 m radius) under low winds (less than 20 km/hr) (Figs. 3 and 6) to more extensive plumes (greater than 2 km long, 500 m wide) (Figs. 4 and 5) under high winds (exceeding 20 km/hr). Since inclement weather did not permit lake sampling at all times, the possibility remains that during storms (winds greater than 30 km/hr), the plumes originating from the lakefill/spoils disposal site were larger than the worst cases observed.

Substantially higher turbidity and suspended solid levels were recorded at the dredging site and near the spoils disposal area during the dredging period than during the predredging period. The dredging activity itself may have been responsible in part for slightly elevated turbidity levels in the Inner Harbour and possibly in the Outer Harbour.

The monitoring results also indicate that dredging and spoils disposal activities did not significantly affect the levels of suspended material in the areas of the R.C. Harris and Toronto Island water intakes.

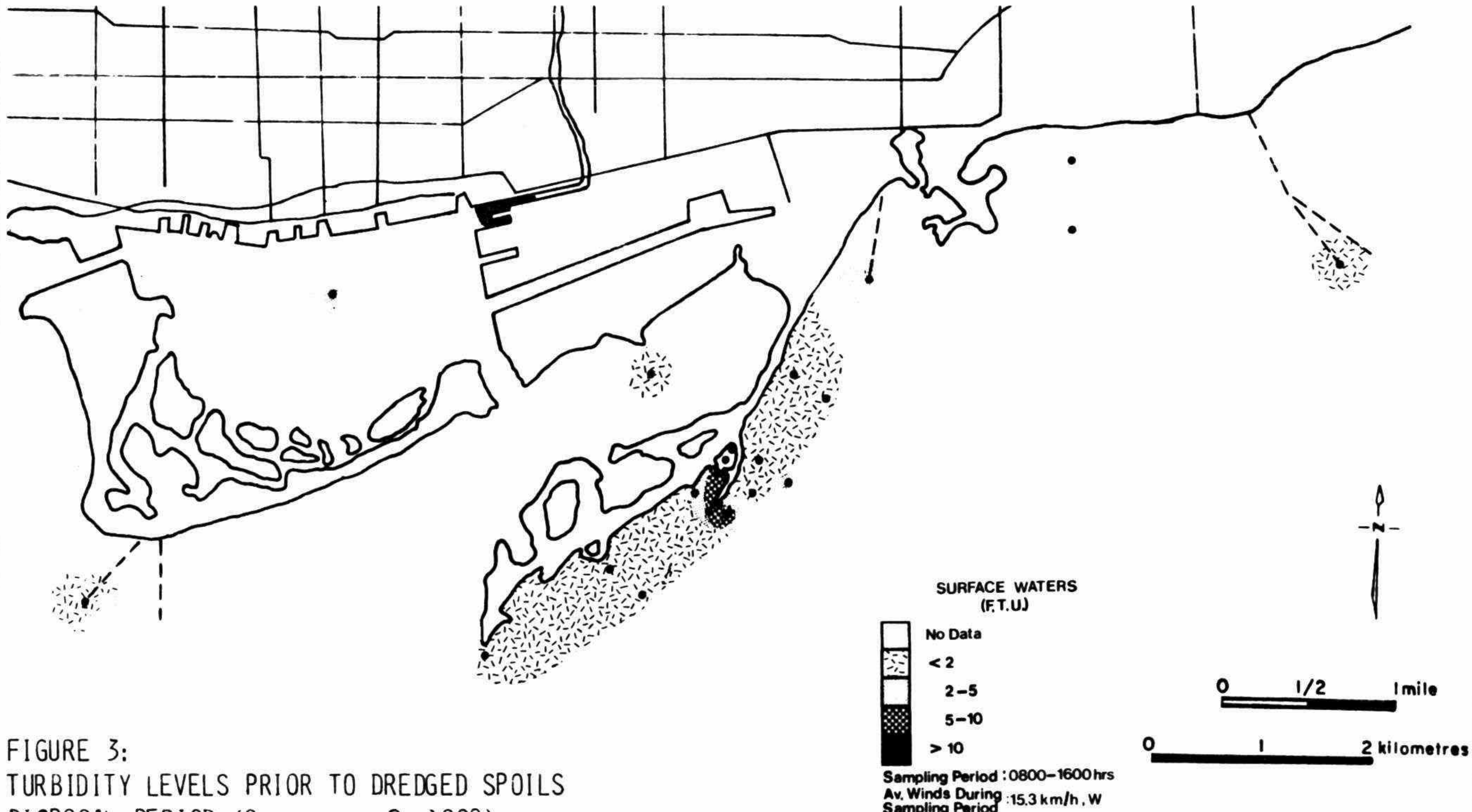


FIGURE 3:
TURBIDITY LEVELS PRIOR TO DREDGED SPOILS
DISPOSAL PERIOD (SEPTEMBER 2, 1980)

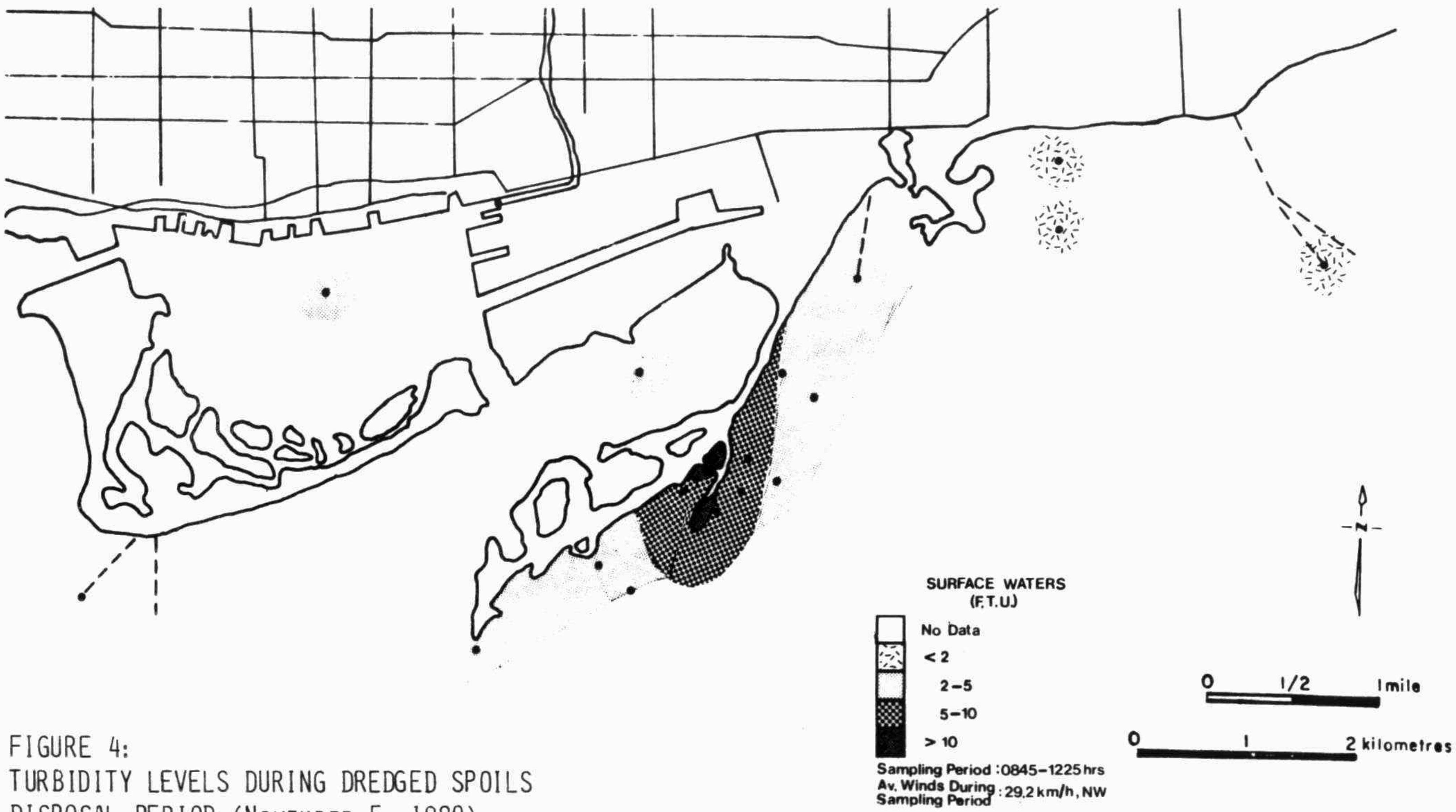


FIGURE 4:
TURBIDITY LEVELS DURING DREDGED SPOILS DISPOSAL PERIOD (NOVEMBER 5, 1980)

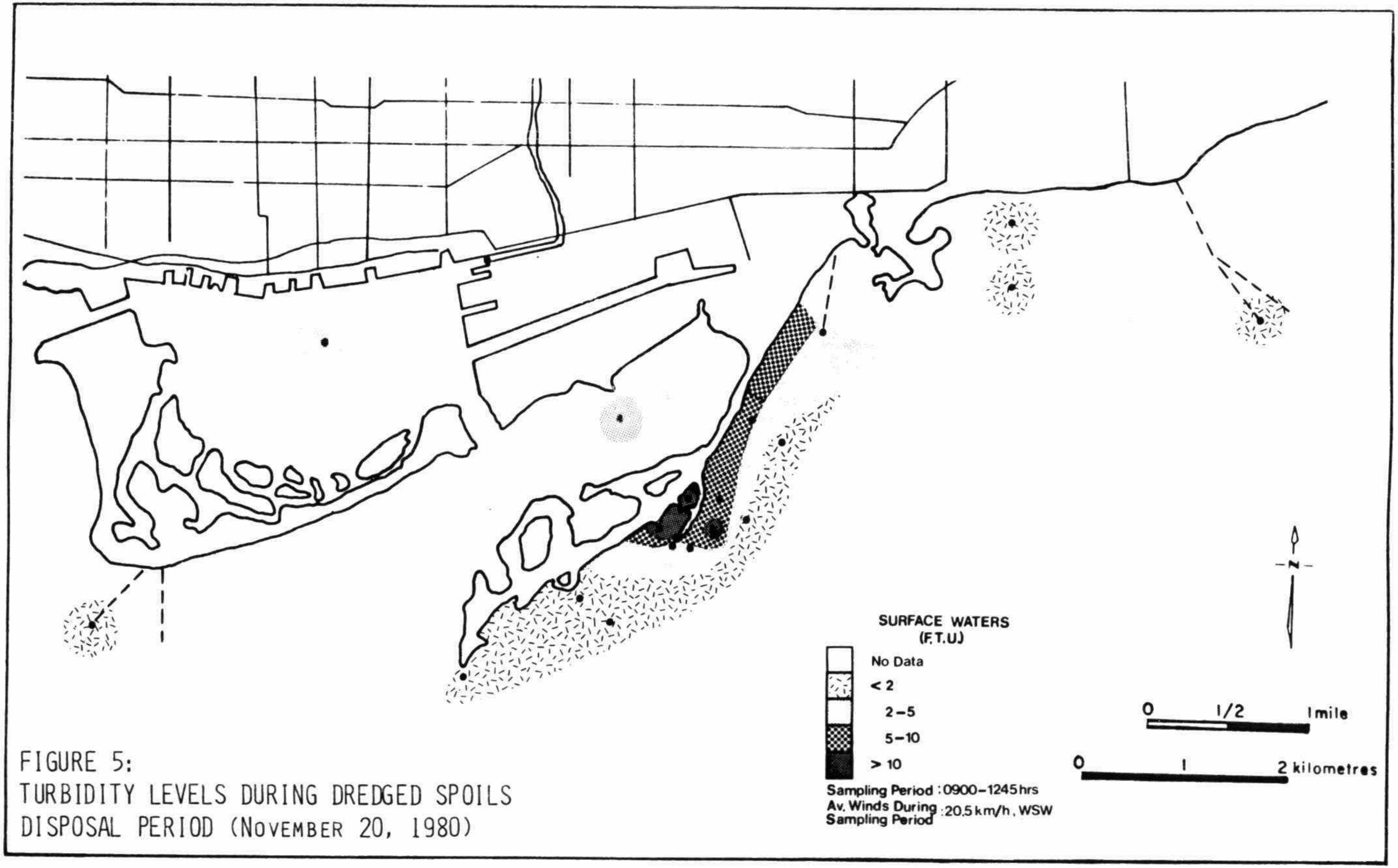


FIGURE 5:
TURBIDITY LEVELS DURING DREDGED SPOILS DISPOSAL PERIOD (NOVEMBER 20, 1980)

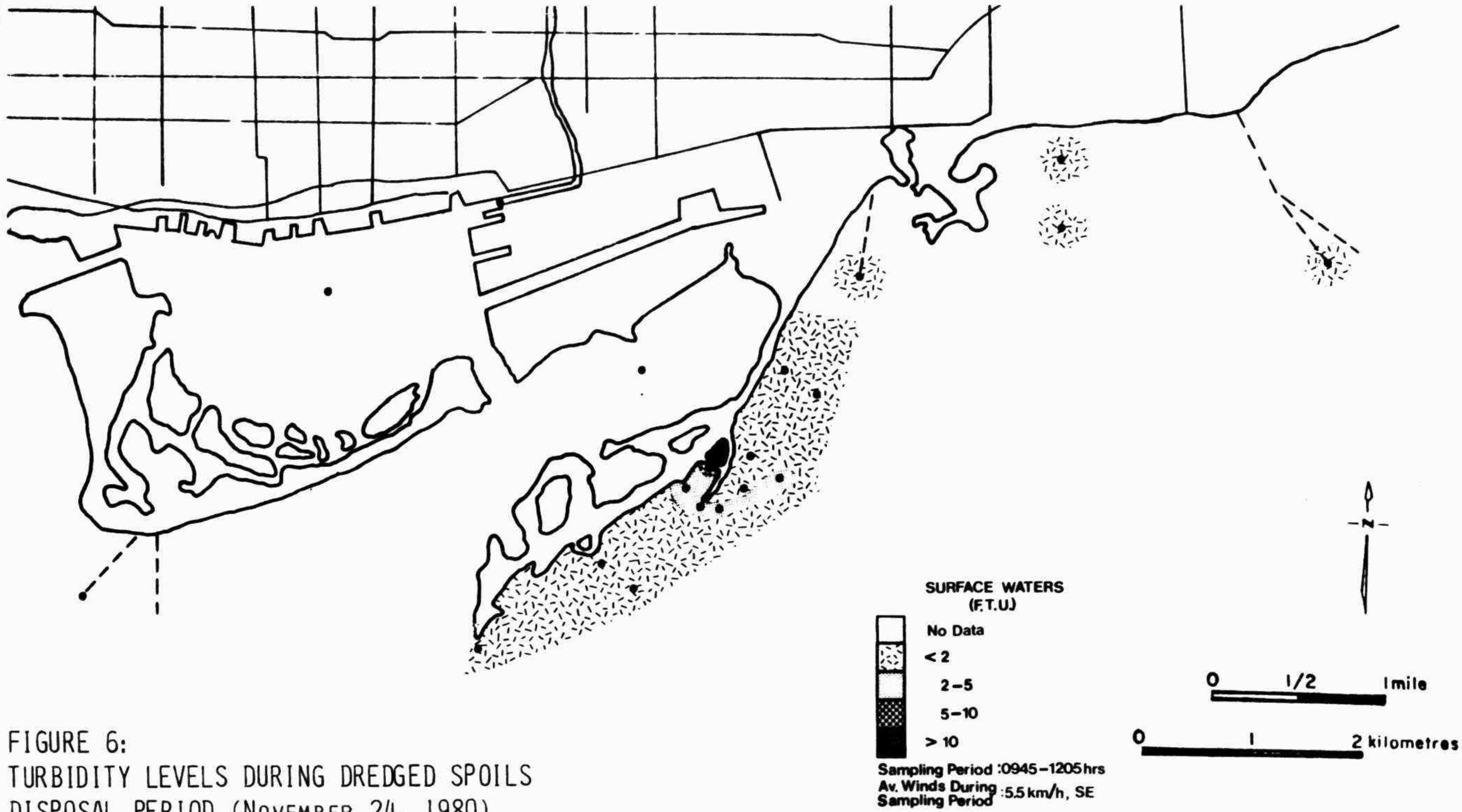
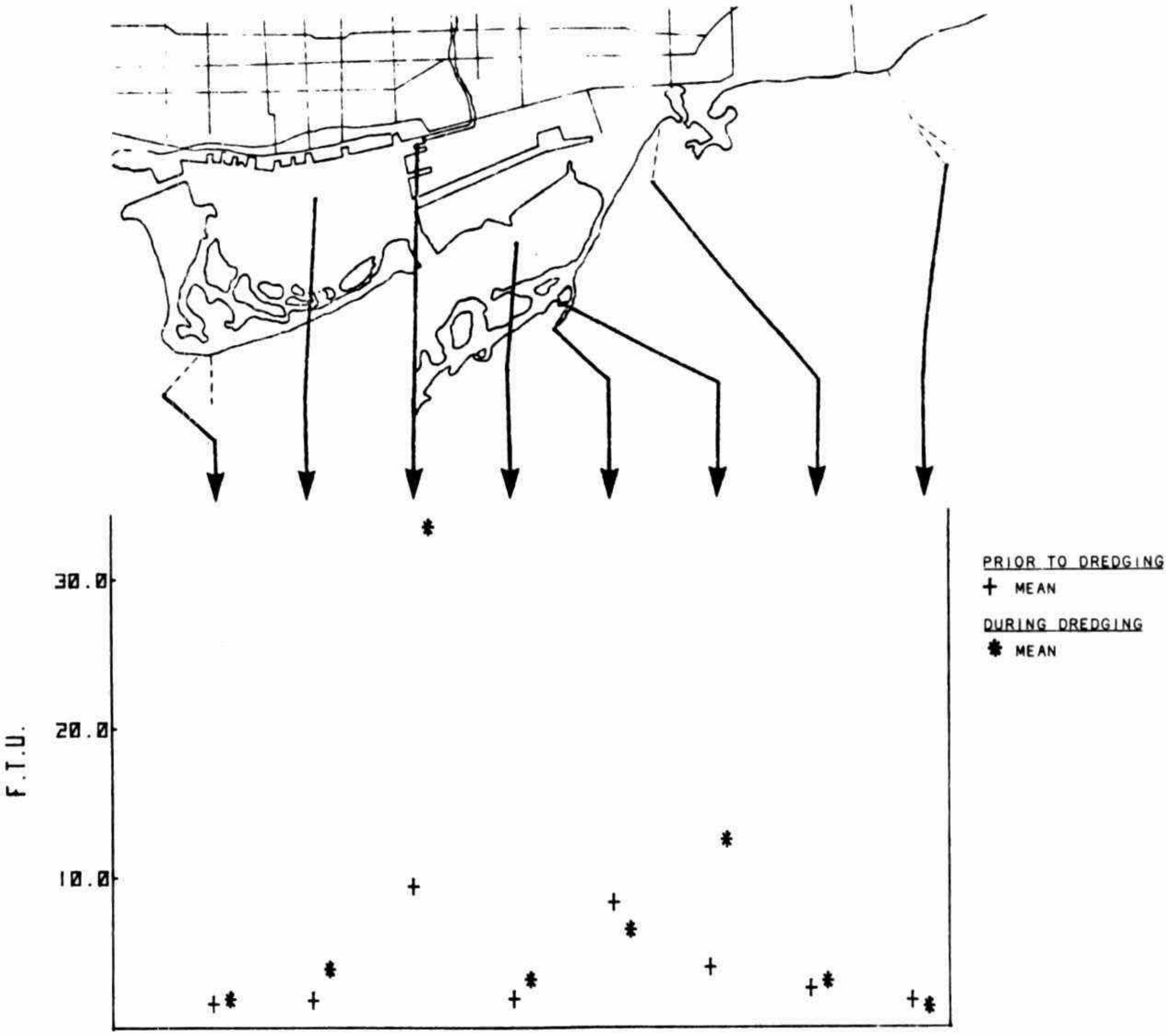


FIGURE 6:
TURBIDITY LEVELS DURING DREDGED SPOILS DISPOSAL PERIOD (NOVEMBER 24, 1980)



		1536	1364	1375	202	1987	1984	1419	1872
	STATION NUMBER	1536	1364	1375	202	1987	1984	1419	1872
PRIOR TO DREDGING	NUMBER OF SAMPLES	11	13	13	13	4	12	14	13
	RANGE	.7-1.8	.7-2.0	1.6-18	.8-2	1-18	1.2-6.3	.9-5.6	.5-3.1
	MEAN	1.1	1.3	9.3	1.4	7.8	3.7	2.1	1.3
DURING DREDGING	NUMBER OF SAMPLES	8	9	9	9	9	9	9	8
	RANGE	1-3	1.6-4.9	5.4-90	1.4-3.8	1.3-31	3.6-27	1.4-4.9	.6-1.5
	MEAN	1.4	3.4	35.4	2.7	6	12	2.6	.9

FIGURE 7: TURBIDITY LEVELS (F.T.U.) ALONG THE TORONTO WATERFRONT PRIOR TO AND DURING DREDGING

It has been reported[1] that waters normally containing from 80 to 400 mg/L suspended solids are unlikely support good freshwater fisheries. It is unlikely that the fish habitat was significantly altered anywhere in the study area except immediately adjacent to the dredging operation where levels of suspended solids in excess of 80 mg/L were observed on four out of nine occasions and the mean concentration was 123 mg/L. Mean suspended solid concentration in the immediate vicinity of the fill site during the study period was 11 mg/L. During the dredged spoils disposal, the mean level at the embayment gap was 18 mg/L. Elsewhere along the waterfront the mean suspended solid levels were below 10 mg/L.

(ii) Conductivity and Alkalinity

Conductivity and alkalinity were found to be weak indicators of changing water quality brought about by dredging and spoils disposal operations. A small increase in conductivity and alkalinity was recorded during spoils disposal at the embayment gap and is believed to be indicative of occasional material loss through the gap during spoils disposal operations. The observed changes in these parameters were not of sufficient magnitude to be environmentally significant.

(iii) Nutrients and Related Parameters

Dredging did not significantly increase levels of phosphorus (Fig. 9) nitrogen or silica even in the immediate area of the activity. Nitrogen (e.g., NO_2 + NO_3 - Fig. 10) and silica levels throughout most of the waterfront were somewhat higher during the dredging than the non-dredging period, but this apparent elevation was believed to be caused by lake-wide effects characteristic of autumn overturn conditions and not by dredging or spoils disposal activities.

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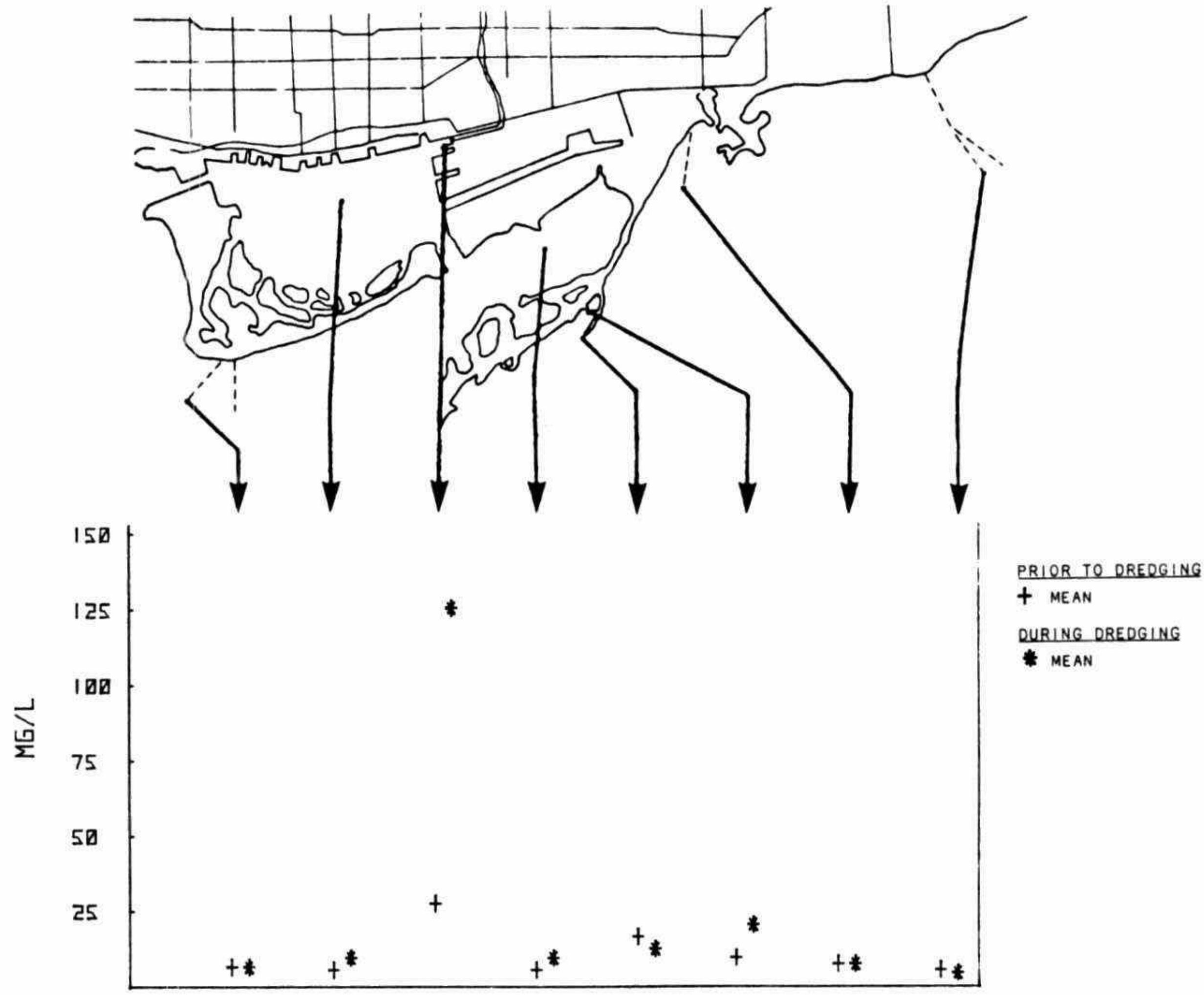
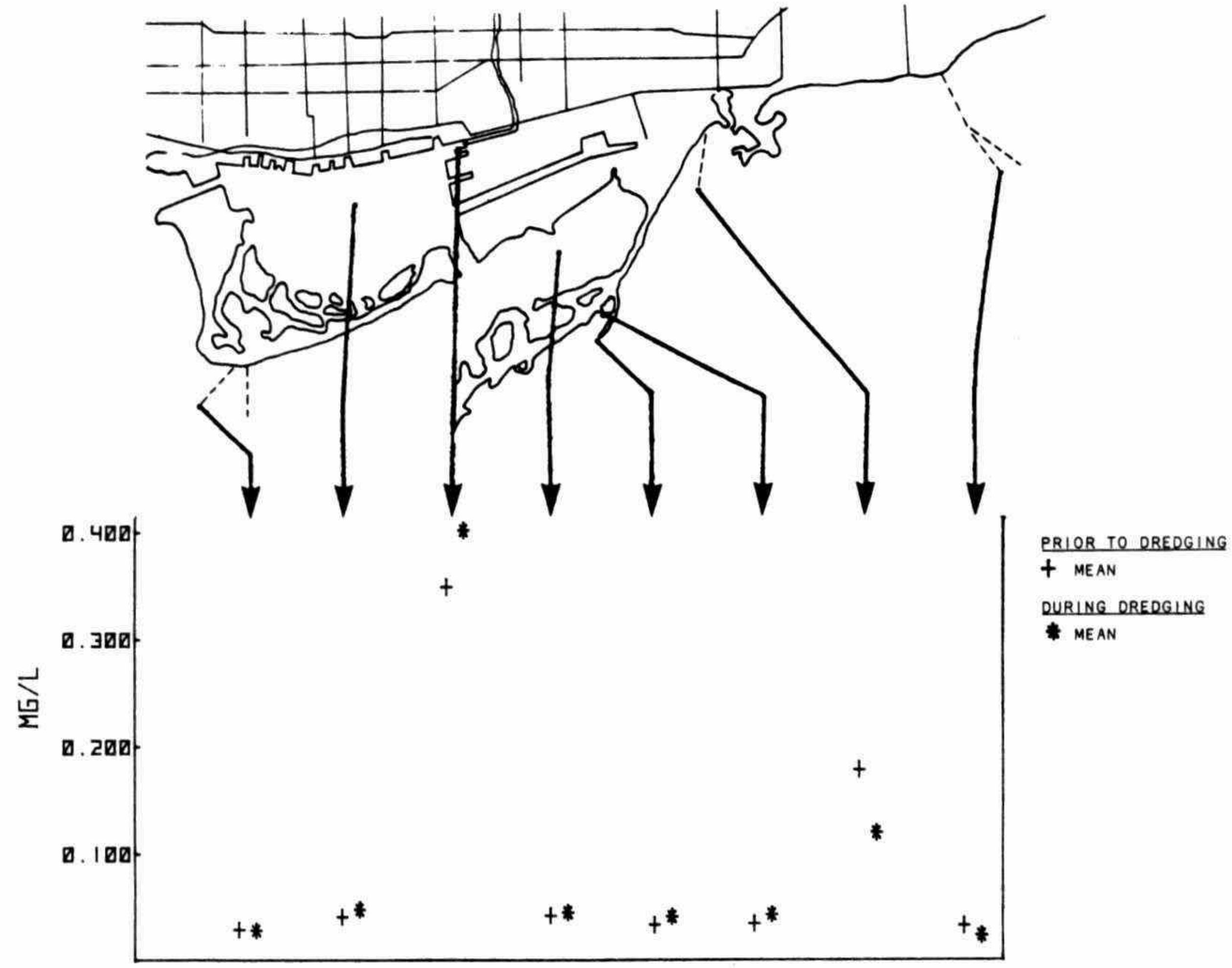
1 U.S. EPA Water Quality Criteria 1972, p.128.



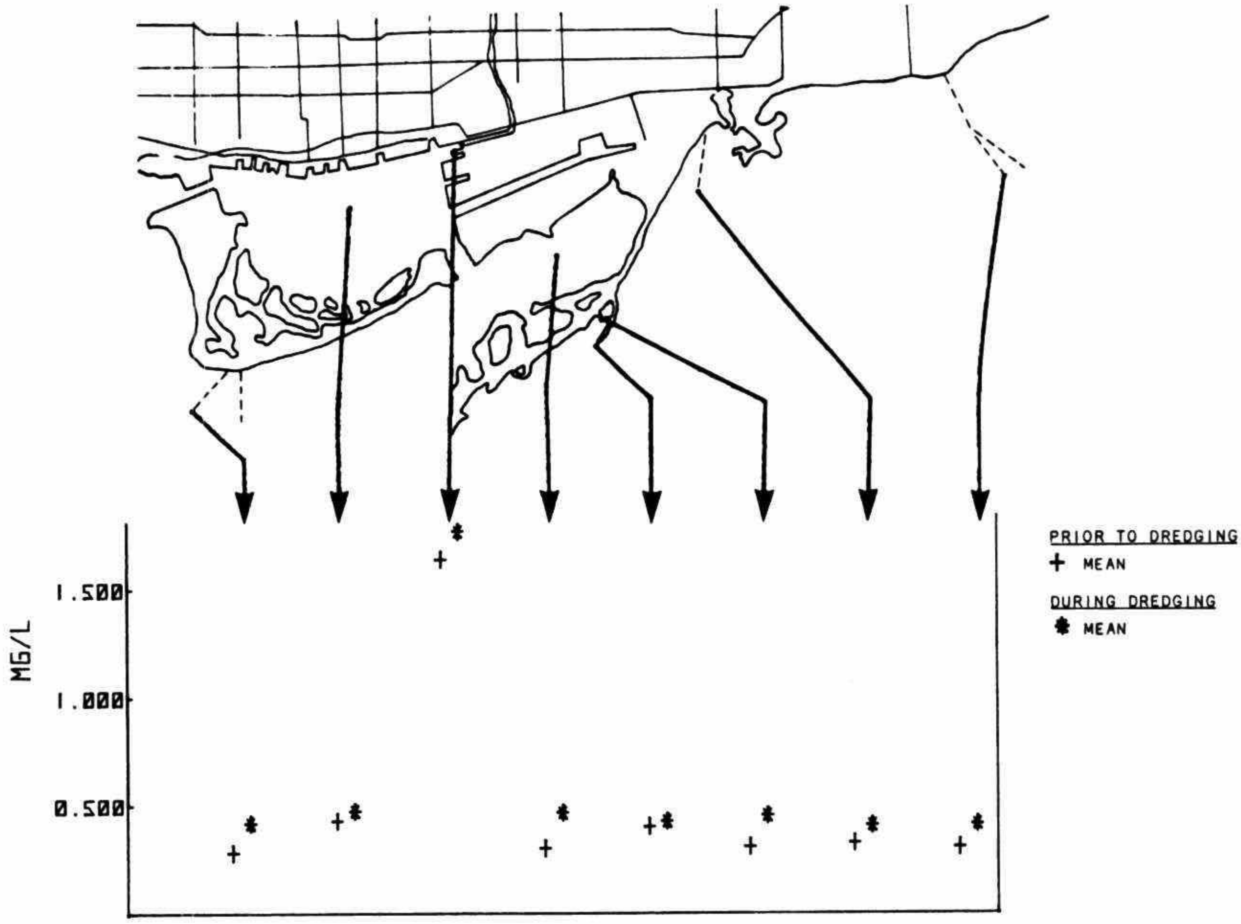
PRIOR TO DREDGING	STATION NUMBER	1536	1364	1375	202	1987	1984	1419	1872
	NUMBER OF SAMPLES	11	13	13	13	4	12	14	13
	RANGE	1-13	2-6	4-53	2-4	2-34	3-13	2-8	0.8-5
	MEAN	4	3	25	3	14	7	5	3
DURING DREDGING	NUMBER OF SAMPLES	8	9	9	9	9	9	9	8
	RANGE	2-11	3-11	15-434	4-10	3-44	5-39	2-9	0.6-3
	MEAN	4	7	123	7	10	18	5	2

FIGURE 8: SUSPENDED SOLIDS LEVELS (mg/L) ALONG THE TORONTO WATERFRONT PRIOR TO AND DURING DREDGING



	STATION NUMBER	1536	1364	1375	202	1987	1984	1419	1872
PRIOR TO DREDGING	NUMBER OF SAMPLES	11	13	13	13	4	12	14	14
	RANGE	.009-.042	.020-.073	.115-.605	.016-.075	.014-.055	.015-.050	.011-.385	.012-.047
	MEAN	.021	.033	.341	.035	.026	.027	.170	.025
DURING DREDGING	NUMBER OF SAMPLES	8	9	8	9	9	9	9	8
	RANGE	.014-.033	.031-.056	.268-.578	.024-.050	.015-.085	.014-.063	.013-.315	.012-.032
	MEAN	.021	.041	.394	.038	.034	.036	.112	.018

FIGURE 9: TOTAL PHOSPHORUS LEVELS (mg/L) ALONG THE TORONTO WATERFRONT PRIOR TO AND DURING DREDGING



		1536	1364	1375	202	1987	1984	1419	1872
PRIOR TO DREDGING	STATION NUMBER	1536	1364	1375	202	1987	1984	1419	1872
	NUMBER OF SAMPLES	11	13	13	13	4	12	14	14
	RANGE	.100-.380	.150-1.60	.845-2.450	.125-.360	.345-.390	.120-.385	.120-.410	.050-.420
	MEAN	.246	.393	1.603	.264	.366	.270	.289	.268
DURING DREDGING	NUMBER OF SAMPLES	8	9	9	9	9	9	9	8
	RANGE	.310-.415	.380-.485	.870-2.250	.365-.480	.335-.430	.330-.455	.305-.430	.305-.400
	MEAN	.382	.439	1.730	.431	.391	.417	.371	.376

FIGURE 10: FILTERED NO_2+NO_3 LEVELS (mg/L) ALONG THE TORONTO WATERFRONT PRIOR TO AND DURING DREDGING

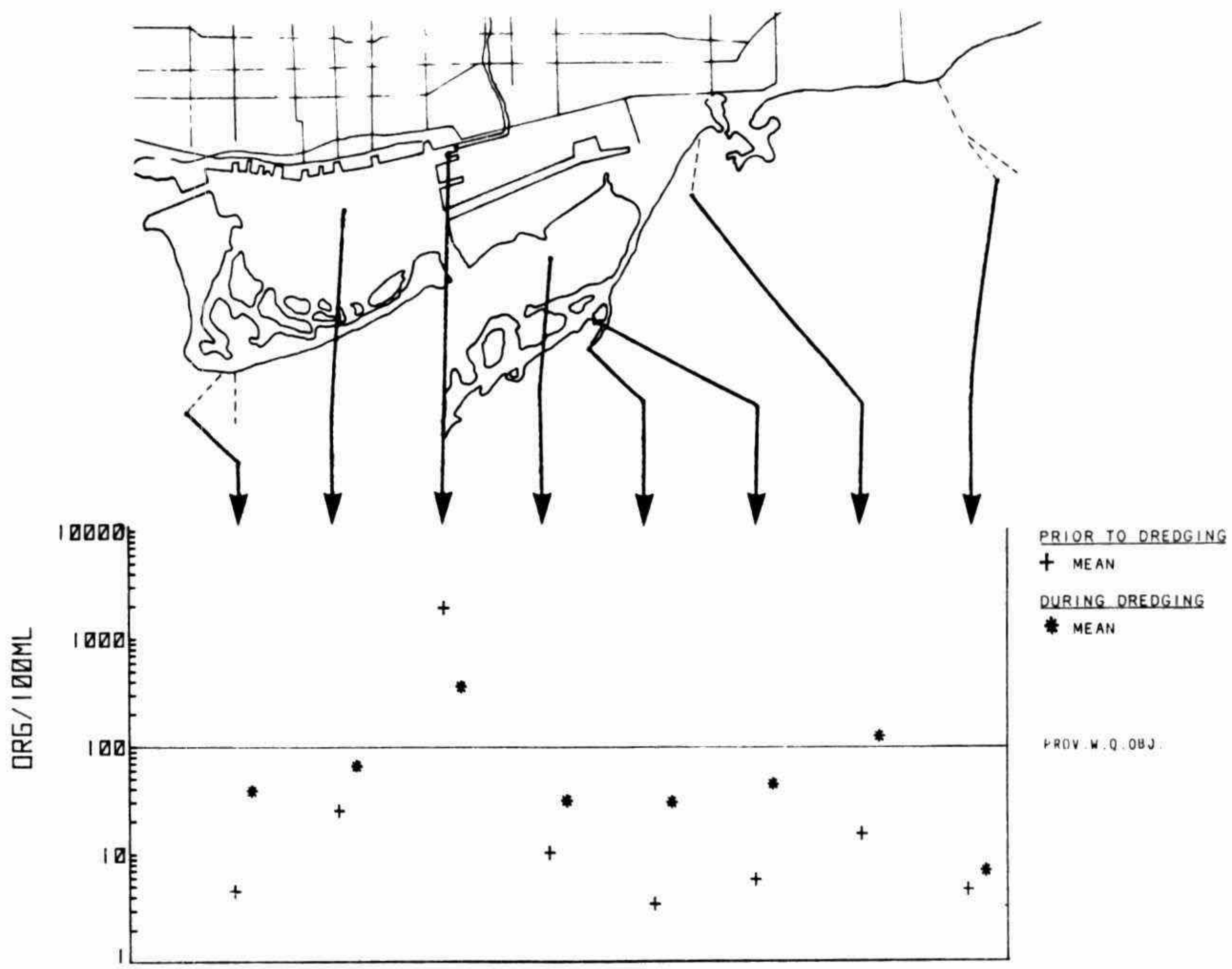
(iv) Bacteria

Monitoring of total coliform, fecal coliform, fecal streptococcus, Pseudomonas aeruginosa and heterotrophic bacteria levels was carried out to assess possible bacterial contamination of the water resulting from construction activities.

Provincial Water Quality Objectives state that water quality is considered impaired for swimming and bathing uses when the geometric mean total coliform densities for a series of water samples exceed 1000 organisms/100 mLs. A potential health hazard exists if the geometric mean fecal coliform density for a series of water samples exceeds 100 organisms/100 mLs.

Bacterial counts were found to be highest at the mouth of the Don River where the levels of total and fecal coliforms were consistently in excess of the Provincial Water Quality Objectives for bathing and swimming throughout the study period (Fig. 11).

Levels of total coliform, fecal coliform, fecal streptococcus and heterotrophic (an indicator of enrichment) bacteria were somewhat higher at most sampling locations during the dredging/spoils disposal period than prior to it. These increases, which did not generally result in levels exceeding the objectives, are felt to be a result of a lake-wide condition related to slower bacterial die-off rates occurring under the lower water temperatures prevailing in the fall and not a result of the dredging/spoils disposal activities. Local increases of coliform bacteria levels near the Toronto Main STP outfall may also, in part, be attributed to the cessation of chlorination of the STP effluent which commenced on October 17, 1980.



	Station Number	1536	1364	1375	202	1987	1984	1419	1872
Prior to Dredging	Number of Samples	11	13	12	13	4	11	14	14
	Range	< 2-80	< 4-376	100->15000	< 2-120	< 2-<4	< 2-48	< 2->600	<2-28
	Geometric Mean	4	22	1655	9	3	5	13	4
During Dredging	Number of Samples	7	8	8	7	8	8	8	7
	Range	< 4->750	<4-550	20->7500	4-532	4->600	4-308	< 10-625	<2-76
	Geometric Mean	34	58	310	27	26	38	104	6

FIGURE 11: FECAL COLIFORM LEVELS (org/100ml) ALONG THE TORONTO WATERFRONT PRIOR TO AND DURING DREDGING

(v) PCBs, Mirex and Organochlorine Pesticides

PCBs and Mirex

The use and manufacture of PCBs in Canada is strictly controlled under specific regulation contained in the Environmental Contaminants Act. Their use is presently limited to closed system industrial applications.

Mirex was not detected anywhere in the waterfront but PCBs were found occasionally in all locations examined (Fig. 12 - refer to page 9 for explanation of range of means derivation). The range of concentrations observed was consistent with values observed elsewhere in Lake Ontario[1]. The measured levels and frequency of detection were highest at the mouth of the Don River where they were present in approximately 50% of the samples. The occurrence of detectable levels of PCBs in the waterfront, did not appear to be related to ongoing lakefilling, dredging or spoils disposal activities.

Organochlorine Pesticides

Chlordane and endosulphan were rarely found in the waters of the Toronto waterfront. Occasional values of endosulphan exceeding the Provincial Water Quality Objective for the protection of aquatic life were observed prior to dredging at several of the sampling locations.

Lindane, as well as α and β BHC were commonly found in trace quantities throughout the waterfront (Fig. 13). Dredging activities at the mouth of the Don River were likely responsible for elevated lindane levels in the immediate area of the dredge site where the PWQO was exceeded on 5 of 9 occasions but did not elevate levels sufficiently in the adjoining Inner Harbour to exceed the objective.

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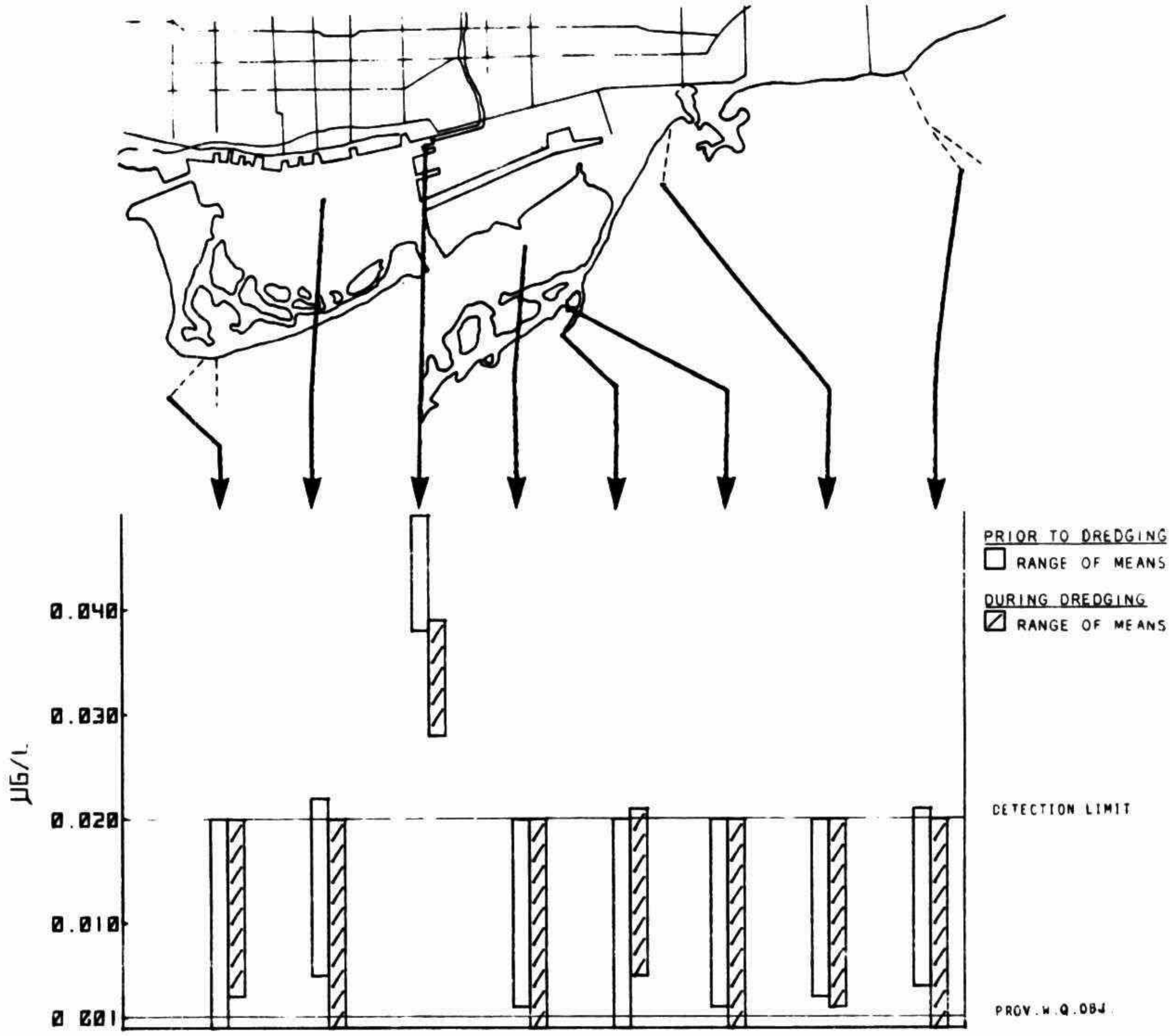
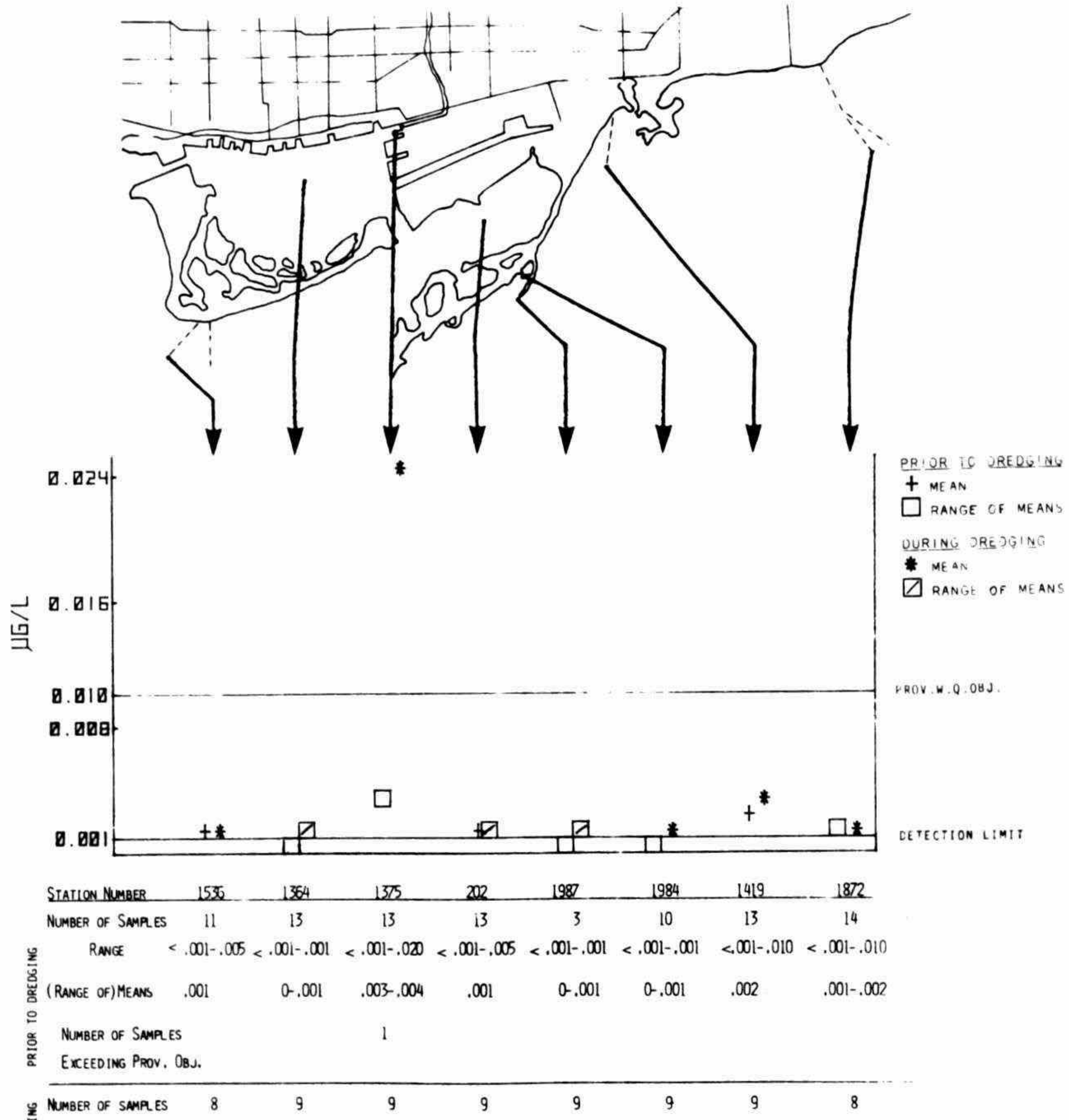
1 Great Lakes Water Quality - Appendix E, Status Report on the Persistent Toxic Pollutants in the Lake Ontario Basin, 1977.



		1536	1364	1375	202	1987	1984	1419	1872
	Station Number	1536	1364	1375	202	1987	1984	1419	1872
Prior to Dredging	Number of Samples	11	13	13	13	3	10	13	14
	Range	<.020	<.020-.040	<.020-.300	<.020-.020	<.020	<.020-.020	<.020-.020	<.020-.030
	Range of Means	0-.020	.005-.022	.038-.046	.002-.020	0-.020	.002-.020	.003-.020	.004-.021
	Number of Samples Exceeding Prov. Obj.		2	6	1		1	2	2
During Dredging	Number of Samples	8	9	9	9	9	9	9	8
	Range	<.020-.020	<.020	<.020-.090	<.020	<.020-.025	<.020	<.020-.020	<.020
	Range of Means	.003-.020	0-.020	.028-.039	0-.020	.006-.021	0-.020	.002-.020	0-.020
	Number of Samples Exceeding Prov. Obj.	1		4		2		1	

Range of Means: Lower value: calculated assuming values less than detection limit = 0
Upper value: calculated assuming values less than detection limit = detection limit

FIGURE 12: PCB LEVELS (µg/L) ALONG THE TORONTO WATERFRONT PRIOR TO AND DURING DREDGING



		Station Number	1536	1364	1375	202	1987	1984	1419	1872
Prior to Dredging		Number of Samples	11	13	13	13	3	10	13	14
		Range	< .001-.005	< .001-.001	< .001-.020	< .001-.005	< .001-.001	< .001-.001	<.001-.010	< .001-.010
		(Range of) Means	.001	0-.001	.003-.004	.001	0-.001	0-.001	.002	.001-.002
		Number of Samples Exceeding Prov. Obj.			1					
During Dredging		Number of Samples	8	9	9	9	9	9	9	8
		Range	< .001-.002	< .001-.003	< .001-.080	< .001-.002	< .001-.007	< .001-.002	<.001-.009	< .001-.001
		(Range of) Means	.001	.001-.002	.024	.001-.002	.001-.002	.001	.003	.001
		Number of Samples Exceeding Prov. Obj.			5					

Range of Means: Lower value: Calculated assuming values less than detection limit = 0
Upper value: Calculated assuming values less than detection limit = detection limit

FIGURE 13: LINDANE LEVELS (µg/L) ALONG THE TORONTO WATERFRONT PRIOR TO AND DURING DREDGING

Several pesticides not actively used in Ontario were found in the waters of the Toronto waterfront. Occasional values in excess of the Provincial Water Quality Objectives for the protection of aquatic life were observed for endrin (Fig. 14), heptachlor epoxide, dieldrin and pp DDE. However, no clear correlation could be detected between dredging/spoils disposal activities and the levels and distribution of these pesticides in the waterfront.

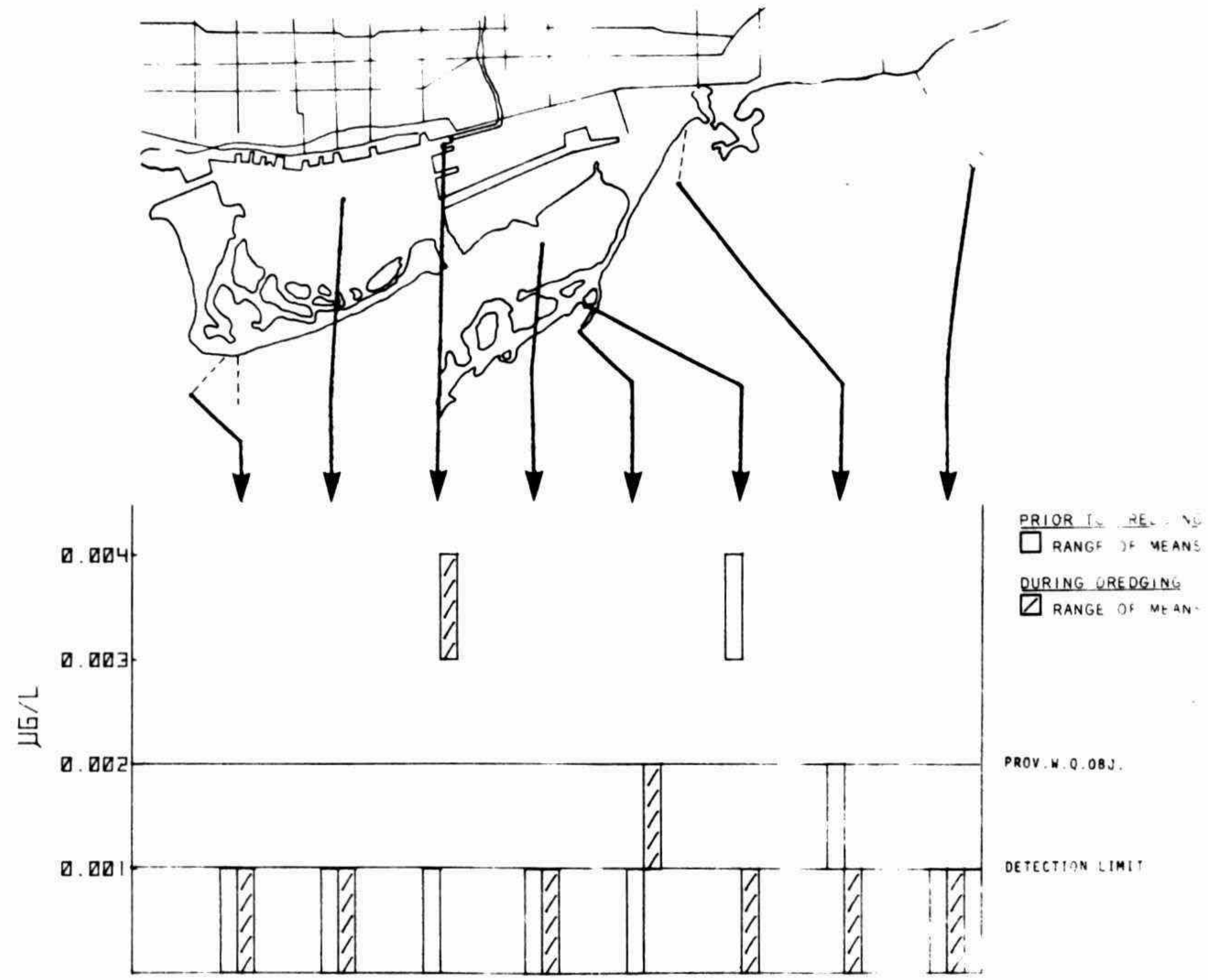
Hexachlorobenzene (HCB)

Detectable levels of HCB (a popular organic primary manufacturing material) were frequently found at the Don River mouth and near the Toronto Main STP outfall (Fig. 15). Neither dredging, dredged spoils disposal nor lakefilling appeared to have any effect on the levels or distribution of HCB. No objective level for the protection of aquatic life has been established for this compound.

(vi) Metals

The dredging activity at the mouth of the Don River was responsible for localized increases in chromium, copper, zinc and lead (Fig. 16) and contributed to levels in excess of Provincial Water Quality Objectives for the latter three. The spoils disposal and lakefilling activities, on the other hand, did not significantly affect the concentrations of any heavy metal either at the embayment gap or at any other location on the waterfront.

Levels in excess of the Provincial Water Quality Objective for cadmium were observed throughout most of the waterfront although they were generally higher prior to dredging. The significance of the widespread distribution at elevated levels will require further investigation.

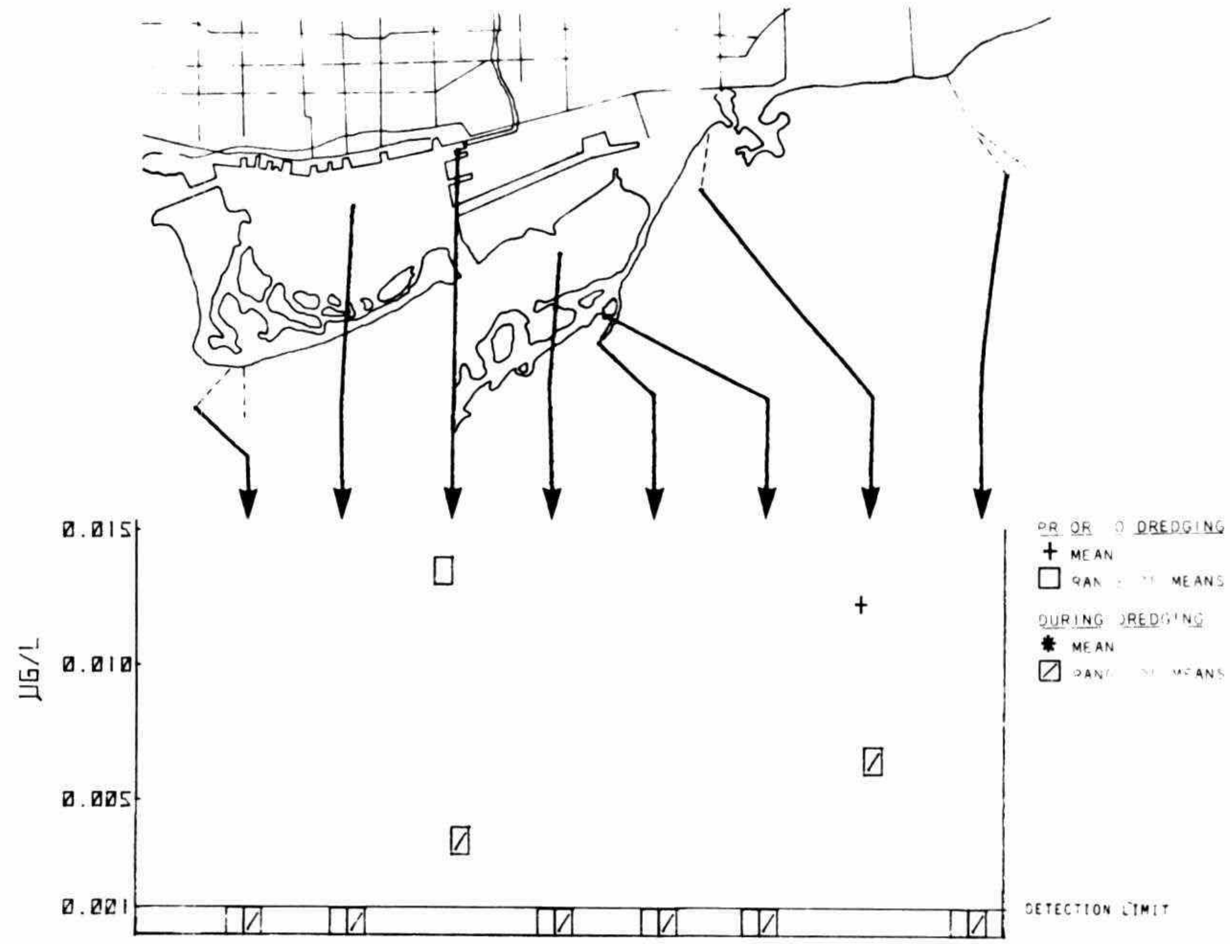


	Station Number	1536	1364	1375	202	1987	1984	1419	1872
Prior to Dredging	Number of Samples	11	13	13	13	3	10	13	4
	Range	<.001	<.001	<.001	<.001-.005	<.001	<.001-.030	<.001-.010	<.001
	Range of Means	0-.001	0-.001	0-.001	0-.001	0-.001	.003-.004	.001-.002	0-.001
	Number of Samples Exceeding Prov. Obj.				1		1	1	
During Dredging	Number of samples	8	9	9	9	9	9	9	8
	Range	< .001	<.001	<.001-.031	<.001	< .001-.012	<.001	<.001	<.001
	Range of Means	0-.001	0-.001	.003-.004	0-.001	.001-.002	0-.001	0-.001	0-.001
	Number of Samples Exceeding Prov. Obj.			1		1			

Range of Means: Lower value: calculated assuming values less than detection limit = 0

Upper value: calculated assuming values less than detection limit = detection limit

FIGURE 14: ENDRIN LEVELS (µg/L) ALONG THE TORONTO WATERFRONT PRIOR TO AND DURING DREDGING

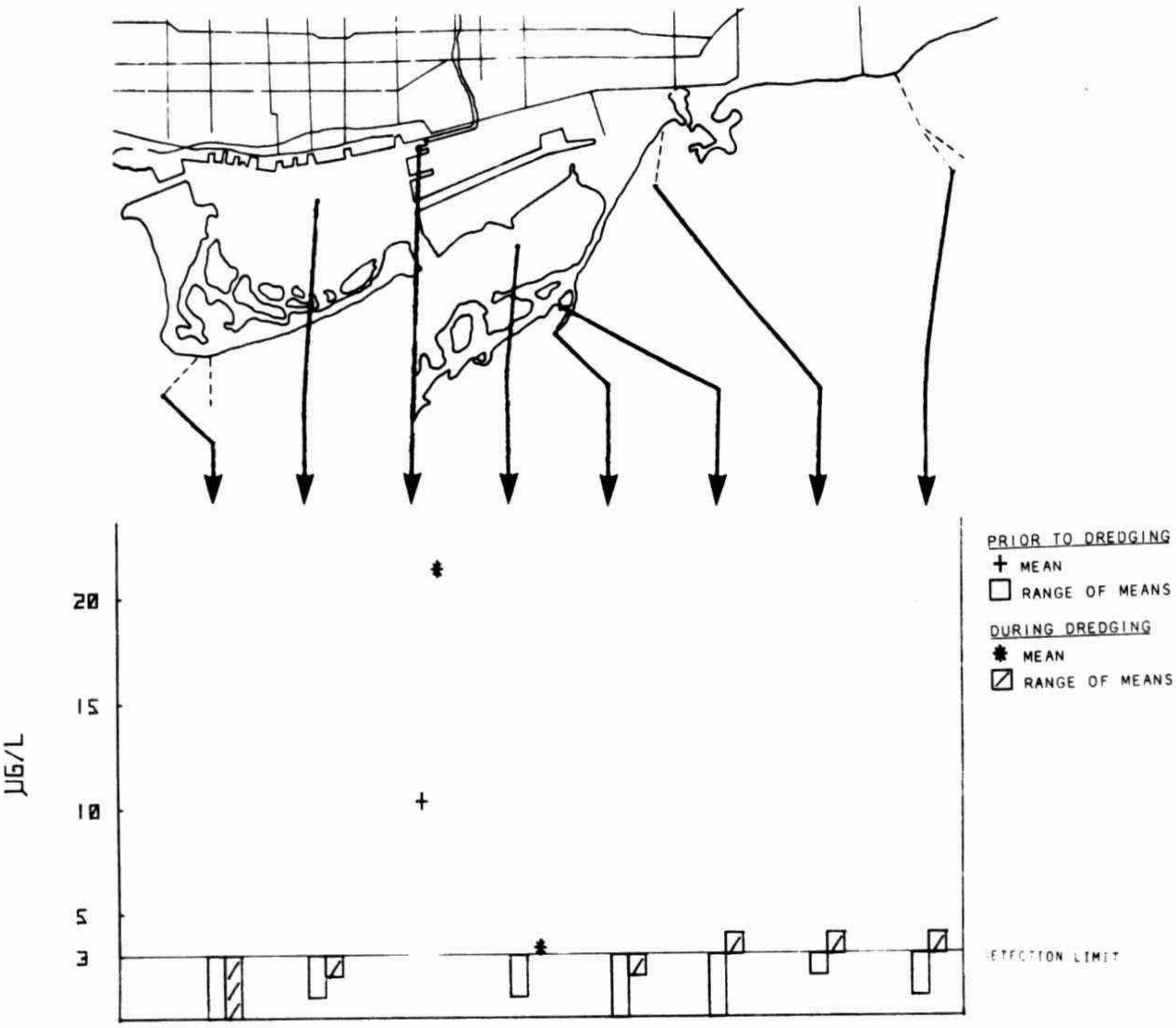


	Station Number	1530	1364	1375	202	1987	1984	1419	1872
PRIOR TO DREDGING	Number of Samples	11	13	15	13	3	10	13	14
	Range	<.001	<.001-.005	<.001-.060	<.001	<.001	<.001-.002	<.001-.030	<.001-.00
	(Range of) Means	0-.001	0-.001	.013-.014	0-.001	0-.001	0-.001	.012	0-.001
DURING DREDGING	Number of Samples	8	9	9	9	9	9	9	8
	Range	<.001	<.001-.001	<.001-.009	<.001	<.001-.001	<.001	<.001-.030	<.001
	Range of Means	0-.001	0-.001	.003-.004	0-.001	0-.001	0-.001	.006-.007	0-.001

RANGE OF MEANS: LOWER VALUE: CALCULATED ASSUMING VALUES LESS THAN DETECTION LIMIT = 0

UPPER VALUE: CALCULATED ASSUMING VALUES LESS THAN DETECTION LIMIT = DETECTION LIMIT

FIGURE 15: HCB LEVELS (µg/L) ALONG THE TORONTO WATERFRONT PRIOR TO AND DURING DREDGING



		Station Number	1536	1304	1375	202	1987	1984	1419	1872
Prior to Dredging	Number of Samples		4	4	4	4	2	4	5	5
	Range		< 3	< 2-3	2-20	< 2-3	< 3	< 3	< 3-5	< 3-5
	(Range of) Means		0-3	1-3	10	1-3	0-3	0-3	2-3	1-3
	Number of Samples Exceeding Prov. Obj.									
During Dredging	Number of Samples		7	9	9	9	9	7	8	5
	Range		< 3-3	< 2-4	6-86	< 3-4	< 3-5	< 3-6	< 3-7	< 3-7
	(Range of) Means		0-3	2-3	21	3	2-3	3-4	3-4	3-4
	Number of Samples Exceeding Prov. Obj.				2					

Range of Means: Lower value: calculated assuming values less than detection limit = 0
Upper value: calculated assuming values less than detection limit = detection limit

FIGURE 16: LEAD LEVELS (μg/L) ALONG THE TORONTO WATERFRONT PRIOR TO AND DURING DREDGING

VI DRINKING WATER QUALITY

Data on raw water and drinking water sampled at the R.C. Harris water filtration plant are summarized (Tables 1 and 2) and discussed in this section and presented in full in the Appendix (Tables 1A-3A). All data collected at the Toronto Island water filtration plant during this study have been reported in a previous publication[1]. The Toronto Island plant, which is generally in operation only during summer peak demand periods, was closed in late August and therefore inoperative throughout most of the study period.

Interpretation of treated (finished) drinking water results was made in relation to the revised Ontario Drinking Water Objectives 1981 (soon to be published). These objectives were established with considerable margins of safety and were based on long-term consumption. Experience in Ontario, as in other jurisdictions, has shown that the occurrence of occasional values exceeding the objective is not unusual and should not be a cause for consumer concern. Note that these objectives do not apply to the raw water.

(i) Turbidity, Nutrients and Associated Parameters

Treatment processes employed at the R.C. Harris filtration plant for purifying raw water for domestic consumption reduced the levels of particulate material in the water, as measured by suspended solids and turbidity. Municipality of Metropolitan Toronto Department of Works' monitoring data, based on average daily turbidity, indicated 100% compliance with the Ontario Drinking Water Objective of 1 FTU.

The nitrate and nitrite levels were similar in both the raw and finished waters and were always within the revised Ontario Drinking Water Objectives. The average nitrate plus nitrite

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1 Griffiths, M. 1980. Effects of Keating Channel Dredge Spoil Disposal and Landfilling at the Headland on the Water Quality in the Toronto Waterfront. May 15 - Aug. 15, 1980. MOE. pp43.

TABLE 1: RAW WATER QUALITY AT THE R.C. HARRIS FILTRATION PLANT PRIOR TO AND DURING DREDGING

		TURB.	S.S.	COND.	ALK.	HARDNESS	TP	F.R.P.	T.K.N.	$NO_2 + NO_3$	NH_3
PRIOR TO DREDGING	NUMBER OF SAMPLES	15	6	15	15	15	15	5	15	15	15
	RANGE	0.4-2.8	< 0.1-1.6	311-335	89-97	127-136	.007-.031	.001-.010	.190-.640	.125-.440	.006-.368
	MEAN	1.1	.5-.6	331	94	134	.014	.005	.254	.339	.045
DURING DREDGING	NUMBER OF SAMPLES	31	31	31	31	30	31	31	31	31	31
	RANGE	0.6-9.3	0.7-33	330-350	91-101	133-144	.012-.033	.002-.018	.150-.700	.305-.585	.006-.238
	MEAN	1.8	3.2	337	96	138	.019	.009	.259	.406	.052
	ALL CONCENTRATIONS	F.T.U.	MG/L	µS/CM	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
	DETECTION LIMIT										

		DSi.	D.O.C.	pH	PCB	HCB	α BHC	LINDANE	β BHC	HEPTACHLOR & HEPT. EPOXIDE	ENDRIN	THIODAN I & II
PRIOR TO DREDGING	NUMBER OF SAMPLES	1	15	15	13	13	13	13	13	13	13	13
	RANGE	.35	1.7-2.4	7.61-8.18	<.020	<.001	<.001-.010	<.001-.005	<.001-.010		<.001-.005	
	(RANGE OF) MEANS	.35	1.9	7.87	0-.020	0-.001	.005-.006	.001	.001-.002	0 - .002	.001-.002	0-.002
DURING DREDGING	NUMBER OF SAMPLES	30	31	31	30	30	30	30	30	30	30	30
	RANGE	.20-.70	1.8-2.1	7.36-8.15	<.020-.030	<.001-.004	<.001-.008	<.001-.002	<.001-.005		<.001	
	(RANGE OF) MEANS	.40	1.9	7.85	.001-.020	0-.001	.004	.001	.001-.002	0 - .002	0-.001	0-.002
	ALL CONCENTRATIONS	MG/L	MG/L		µG/L	µG/L	µG/L	µG/L	µG/L	µG/L	µG/L	µG/L
	DETECTION LIMIT				.020	.001	.001	.001	.001	.002	.001	.002

		ALDRIN & DIELDRIN	DDT & METABOLITES	α & γ CHLORDANE	MIREX	CR	PB	ZN	CU	Al	TOTAL HG	CD
PRIOR TO DREDGING	NUMBER OF SAMPLES	13	13	13	13	5	5	5	5	4	13	5
	RANGE				<.005	<2-3	<3-5	5-11	4-12	8-31	<.02-.09	<.2-.4
	(RANGE OF) MEANS	0-.002	0-.016	0-.002	0-.005	1-2	2-4	7	8	20	.01-.03	.3
DURING DREDGING	NUMBER OF SAMPLES	30	30	30	30	30	30	30	30	30	30	30
	RANGE				< .005	< 2-8	< 3-4	3-13	1-19	<2-1400	<.02-.07	<.2-.3
	(RANGE OF) MEANS	0-.002	0-.016	0.002	0-.005	1-2	0-3	6	6	118	.0-.04	0-.2
	ALL CONCENTRATIONS	µG/L	µG/L	µG/L	µG/L	µG/L	µG/L	µG/L	µG/L	µG/L	µG/L	µG/L
	DETECTION LIMIT	.002	.016	.002	.005	2	3	1	1	2	.02-.06	.2

TABLE 2: FINISHED WATER QUALITY AT THE R.C. HARRIŞ FILTRATION PLANT PRIOR TO AND DURING DREDGING

		Turb.	S.S.	Cond.	Alk.	Hardness	TP	F.R.P.	T.K.N.	NO_2+NO_3	NH_3
Prior to Dredging	Number of Samples	15	6	15	15	15	15	5	15	15	15
	Range	.24-.44	< 0.1-0.2	315-340	82-92	129-136	.004-.040	.002-.011	.220-.640	.125-.495	.020-.540
	Mean	.37	0.1	333	89	134	.011	.005	.295	.347	.161
During Dredging	Number of Samples	31	31	31	30	30	30	31	31	31	31
	Range	.24-.45	< 0.1-1	335-355	84-93	133-143	.005-.019	.001-.018	.140-.340	.310-.695	.004-.242
	Mean	.37	0.4	340	90	138	.012	.009	.222	.405	.091
	Prov. Drinking Water Quality Obj.	1	NA	NA	NA	NA	NA	NA	NA	10	NA
	All Concentrations	F.T.U.	mg/L	µs/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	Detection Limit										

		D.SI.	D.O.C.	pH	PCB	HCB	α BHC	Lindane	β BHC	Heptachlor & Hept. Epoxide	Endrin	Thiodan I & II
Prior to Dredging	Number of Samples	1	15	15	14	14	14	14	14	14	14	14
	Range	.55	1.7-2.2	7.33-7.80	< .02-.080	< .001	< .001-.100	< .001-.002	< .001-.001		< .001	
	(Range of) Means	.55	1.9	7.51	.006-.024	0-.001	.011-.012	0-.001	0-.001	0-.002	0-.001	0-.002
During Dredging	Number of Samples	31	31	31	30	30	30	30	30	30	30	30
	Range	.460-.70	1.7-2.1	7.04-7.78	< .020-.030	< .001-.010	< .001-.014	< .001-.011	< .001-.005		< .001-.005	
	(Range of) Means	.59	1.8	7.44	.002-.020	0-.001	.004	.001	.001	0-.002	0-.001	0-.002
	Prov. Drinking Water Quality Obj.	NA	NA	NA	3	NA	NA	4	NA	3	.2	NA
	All Concentrations	mg/L	mg/L		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Detection Limit				.020	.001	.001	.001	.001	.002	.001	.002

		Aldrin & Dieldrin	DDT & Metabolites	α & γ Chlordane	Mirex	Cr	Pb	Zn	Cu	Al	Total Hg	Cd
Prior to Dredging	Number of Samples	14	14	14	14	5	5	5	5	4	13	5
	Range				< .005	< 2	< 3-4	3-6	2-13	26-72	< .04	< .2-.4
	(Range of) Means	0-.002	0-.016	0-.002	0-.005	0-2	1-3	5	5	44	0-.03	.1-.2
During Dredging	Number of Samples	30	30	30	30	31	31	31	31	31	31	31
	Range				< .005	< 2-4	< 3-5	3-33	< 1-80	< 2-300	< .02-.06	< .2-.3
	(Range of) Means	0-.002	0-.016	0-.002	0-.005	0-2	0-3	6	6-7	69	.01-.04	0-.2
	Prov. Drinking Water Quality Obj.	.7	30	7	NA	50	50	5000	1000	NA	1	5
	All Concentrations	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Detection Limit	.002	.016	.002	.005	2	3	1	1	2	.02-.06	.2

level in drinking water was 0.4 mg/L and the maximum recorded was 0.7 mg/L a value well below the 10 mg/L drinking water objective. Dissolved silica, aluminium and ammonia were found in higher concentrations in the treated water than in the raw water. These increases relate to the addition of hydrofluosilicic acid, alum and gaseous ammonia as a normal and necessary part of the treatment process. None of the nutrient or related parameter levels in either the raw or finished waters showed any environmentally significant differences between the dredging and non-dredging periods.

(ii) PCBs and Other Organochlorine Compounds

With a few exceptions, PCBs were absent from both the raw and finished waters collected at the R.C. Harris filtration plant. Although on 3 out of 44 occasions the presence of PCBs was recorded in the finished drinking water, even the highest value (0.08 μg/L) was far below the 3 μg/L interim objective set by the Province for drinking water (The validity of the 0.08 μg/L result is questionable as sample contamination is suspected). In some instances, the presence of PCBs was noted only in the drinking water and not in the corresponding raw water sample. This situation can be attributed to the fact that the sampled incoming raw water was not necessarily of the same batch as the sampled finished water (see page 8).

Many of the organochlorine compounds were not detected in either the raw or finished drinking waters. (Appendix, Table 2A). These included heptachlor, thiodan I, opDDT, ppDDD, ppDDT, α chlordane, γ chlordane, aldrin, dieldrin and mirex. Several others were present in raw and/or finished waters in trace quantities which were considered insignificant. Finished drinking water commonly contained minute quantities of α BHC and β BHC, lindane and occasionally heptachlor epoxide, endrin, thiodan II, ppDDE and HCB, but at concentrations several orders of magnitude lower than the revised Ontario Drinking Water Objectives. At no time

did the total measured pesticide level in finished water exceed or approach the 0.1 mg/L (100 µg/L) revised Ontario Drinking Water Objective. It has been shown in separate studies that the trihalomethanes and other organics in the drinking water have been also consistently in compliance with the revised Ontario Drinking Water Objectives.

No correlation was apparent between organochlorine levels in either raw or finished water at the R.C. Harris plant and the dredging/dredged spoils disposal activities in the waterfront.

(iii) Metals

Concentrations of chromium, lead, zinc, mercury, copper and cadmium in the R.C. Harris finished water were most often either below detection or near detection levels and thus much below the revised Ontario Drinking Water Objectives (Appendix, Table 3A).

There is no evidence to suggest that dredging, dredged spoils disposal, lakefilling activities or any other Toronto waterfront discharges adversely affected the quality of drinking water distributed by the R.C. Harris water filtration plant. All finished drinking water samples, collected at the R.C. Harris filtration plant met the revised Ontario Drinking Water Objectives. Data collected at the Toronto Island filtration plant and presented in a previous report, also showed compliance with all Ontario Drinking Water Objectives at all times.

A P P E N D I X

ABBREVIATIONS, UNITS AND SYMBOLS USED IN TABLES

ABBREVIATIONS

ALK.	Alkalinity
COND.	Conductivity
DOC	Dissolved Organic Carbon
F.R.P.	Filtered Reactive Phosphate
F.T.U.	Formazin Turbidity Units
S.S.	Suspended Solids
T.K.N.	Total Kjeldahl Nitrogen
T P	Total Phosphorus
TURB	Turbidity

UNITS

mg/L	milligrams per litre
ug/L	micrograms per litre
μS/cm	microsiemens per centimetre

SYMBOLS

<	less than
>	greater than
X	not detected

TABLE 1A: WATER QUALITY (RAW AND FINISHED) AT THE R.C. HARRIS FILTRATION PLANT : NUTRIENTS AND ASSOCIATED PARAMETERS (August 27 – November 28, 1980)

Date	Source	FRP µg/L	TP µg/L	$NO_2 + NO_3$ µg/L	NH_3 µg/L	TKN µg/L	Cond. µS/cm	Turb. F.T.U.	Hardness mg/L	D.Si. µg/L	SS mg/L	DOC mg/L	Alk. mg/L	pH
Aug. 27	raw		14	165	40	250	320	0.35	130			2.1	90	8.07
	finished		9	200	174	290	320	0.30	129			2.1	86	7.61
Aug. 28	raw		13	135	41	270	320	2.00	130			2.1	90	8.15
	finished		7	155	149	290	325	0.38	130			2.0	85	7.65
Aug. 29	raw		21	125	60	310	311	2.80	127			2.4	89	8.18
	finished		9	125	149	290	315	0.32	129			2.2	82	7.60
Sept. 29	raw		14	425	6	230	335	1.20	135			2.0	96	7.79
	finished		9	495	138	290	340	0.24	136			2.0	91	7.64
Sept. 30	raw		14	395	16	210	335	1.60	135			1.9	95	7.71
	finished		8	385	148	260	335	0.34	134			2.1	91	7.39
Oct. 1	raw		11	355	10	230	335	0.95	135			1.9	95	7.87
	finished		9	360	142	260	335	0.36	134			1.9	90	7.45
Oct. 2	raw		10	355	12	190	335	1.00	134			2.0	94	8.01
	finished		7	355	140	240	335	0.39	133			1.9	90	7.61
Oct. 3	raw		7	325	12	210	330	0.91	134			2.0	94	8.18
	finished		4	335	116	280	335	0.39	134			2.0	89	7.57
Oct. 6	raw		9	395	20	210	335	0.96	136			1.8	95	7.68
	finished		5	400	132	260	335	0.42	135			1.7	90	7.40
Oct. 7	raw	7	10	440	20	200	335	0.85	136		< 0.1	1.9	96	7.74
	finished	6	10	420	142	290	335	0.42	135		< 0.1	1.9	91	7.39
Oct. 8	raw	10	15	415	8	210	335	0.87	136		0.2	1.9	96	7.85
	finished	11	12	420	20	220	335	0.44	135		< 0.1	1.9	91	7.35
Oct. 9	raw		31	390	368	640	335	1.10	135		0.8	1.9	95	7.80
	finished		40	405	540	640	335	0.33	135		< 0.1	1.7	90	7.36
Oct. 10	raw	3	13	390	34	200	335	0.93	135		1.6	1.7	95	7.80
	finished	2	9	385	112	230	335	0.40	136		0.2	1.8	91	7.80
Oct. 14	raw	3	12	390	14	240	335	0.78	136		0.2	1.8	97	7.61
	finished	3	10	385	164	260	340	0.43	135		< 0.1	1.9	91	7.33
Oct. 15	raw	1	12	380	14	210	335	0.66	135	0.35	0.4	1.7	96	7.66
	finished	3	12	380	154	320	335	0.42	135	0.55	0.2	1.7	92	7.56
Oct. 16	raw	10	25	370	208	410	340	0.95	135	0.35	1.8	1.9	97	7.57
	finished	9	16	375	136	270	340	0.44	136	0.55	0.6	1.8	88	7.12
Oct. 17	raw	2	13	305	26	210	330	0.81	134	0.20	1.2	1.9	96	7.80
	finished	1	13	310	126	300	335	0.31	133	0.45	0.4	1.8	91	7.39
Oct. 20	raw	2	15	355	16	250	330	0.76	138	0.30	1	2.0	95	8.02
	finished	3	10	350	146	280	335	0.38	138	0.50	0.3	1.9	91	7.29
Oct. 21	raw	3	12	365	12	220	330	0.64	138	0.35	0.7	1.8	96	7.89
	finished	4	9	370	14	180	335	0.40	137	0.55	< 0.1	1.9	91	7.50
Oct. 22	raw	7	14	435	8	170	335	0.71	135	0.40	1.0	1.9	97	7.46
	finished	4	8	430	146	250	335	0.37	135	0.60	< 0.1	1.9	91	7.41
Oct. 23	raw	7	16	420	16	190	335	0.90	136	0.40	2	1.9	97	7.98
	finished	7	12	420	76	200	340	0.37	136	0.65	1	1.8	91	7.38
Oct. 24	raw	6	21	420	70	270	335	4.30	133	0.40	8	2.0	97	7.76
	finished	4	5	410	150	270	335	0.35	135	0.60	< 0.1	1.8	91	7.47
Oct. 27	raw	7	21	400	8	180	330	0.91	139	0.35	2	2.1	96	8.03
	finished	5	10	380	36	150	335	0.33	143	0.55	< 0.1	1.8	91	7.65
Oct. 28	raw	11	20	390	8	180	335	0.77	134	0.35	3	1.9	97	7.66
	finished	10	13	390	4	140	335	0.36	135	0.60	0.5	2.0	92	7.56
Oct. 29	raw	10	14	385	14	190	335	0.81	135	0.40	1	1.9	97	7.81
	finished	10	11	385	6	170	335	0.42	134	0.60	< 0.1	1.9	92	7.42
Oct. 30	raw	6	13	370	10	230	335	0.91	135	0.35	1	2.0	98	7.45
	finished	8	19	380	4	150	355	0.44	139	0.55	0.9	1.9	92	7.68
Oct. 31	raw	7	18	395	20	190	350	1.10	136	0.30	2	2.1	97	7.92
	finished	5	13	380	10	160	355	0.35	137	0.50	< 0.1	2.1	92	7.51
Nov. 3	raw	5	14	380	22	240	335	1.40	138	0.35	1.0	2.0	97	7.87
	finished	5	6	380	96	200	340	0.38	138	0.50	< 0.1	1.9	91	7.43
Nov. 4	raw	18	23	430	118	340	340	1.60	137	0.30	5	2.1	96	7.73
	finished	6	8	425	164	310	345	0.34	137	0.55	0.8	2.0	88	7.40
Nov. 5	raw	10	19	685	126	700	335	1.90	137	0.40	2	1.8	97	7.93
	finished	11	14	695	242	270	335	0.36	135	0.60	0.4	1.8	93	7.52
Nov. 6	raw	10	17	385	6	180	335	1.40	139	0.45	2	1.8	97	7.94
	finished	11	12	385	152	260	335	0.37	139	0.70	< 0.3	1.7	92	7.78
Nov. 7	raw	11	18	390	6	220	335	0.85	139	0.50	2	1.8	97	7.92
	finished	12	14	390	130	230	335	0.37	139	0.70	1	1.8	93	7.75
Nov. 10	raw	11	16	390	8	170	335	0.85	138	0.45	1	1.8	96	7.74
	finished	11		390	92	180	335	0.35	139	0.70	< 0.1	1.7	91	7.25
Nov. 12	raw	17	31	410	238	470	345	3.00	139	0.50	2	2.0	99	7.85
	finished	5	10	400	154	270	350	0.30	140	0.65	0.1	1.7	84	7.53
Nov. 13	raw	13	31	430	168	430	345	1.80	139	0.35	4	2.1	98	8.03
	finished	8	9	410	10	200	345	0.36	142	0.60	1	1.8	87	7.25
Nov. 14	raw	8	16	385	8	190	335	1.80	137	0.50	2	1.8	101	8.05
	finished	8	10	385	6	150	340	0.41	137	0.60	0.8	1.7	89	7.41
Nov. 17	raw	11	26	430	82	330	340	1.10	139	0.40	3	2.0	96	7.97
	finished	10	15	415	8	190	345	0.28		0.65	0.8	1.8		7.15
Nov. 18	raw	10	22	410	12	260	335	0.88		0.45	3	2.0	95	7.96
	finished	6	9	400	10	140	340	0.39	139	0.65	0.7	1.7	89	7.20
Nov. 19	raw	11	16	390	8	150	340	0.88	139	0.70	2	1.8	91	7.36
	finished	16	19	385	4	140	340	0.39	139	0.70	0.5	1.8	90	7.35
Nov. 20	raw	11	13	380	8	160	335	1.20	139	0.45	1	1.9	94	7.91
	finished	16	17	385	6	150	340	0.43	139	0.65	0.6	1.9	89	7.48
Nov. 21	raw	11	14	400	6	160	335	0.76	138	0.40	0.9	1.8	95	7.82
	finished	18	18	460	164	270	340	0.34	137	0.60	0.2	1.8	91	7.62
Nov. 24	raw	7	15	395	20	190	335	0.99	139	0.40	1	1.9	96	7.98
	finished	13	19	395	128	250	335	0.43	139	0.60	< 0.1	1.8	92	7.65
Nov. 25	raw	8	16	430	48	190	335	1.00	141	0.40	2	1.9	96	8.01
	finished	13	17	430	150	250	340	0.45	141	0.60	0.6	1.8	91	7.04
Nov. 26	raw	7	26	440	222	420	350	1.90	140		7	1.8	93	7.71
	finished	11	11	420	188	340	350	0.42	139	0.50	0.4	1.8	84	7.46
Nov. 27	raw	5	16	405	48	260	340	9.30	144	0.30	1	1.9	97	8.14
	finished	14	16	405	110	250	345	0.39	141	0.55	< 0.1	1.9	88	7.47
Nov. 28	raw	11	33	425	38	280	340	9.00	142	0.40	33	1.9	100	8.15
	finished	7	7	420	156	300	345	0.24	137	0.55	< 0.1	1.8	89	7.59

TABLE 2A: PCB, MIREX AND PESTICIDE LEVELS (µg/L) IN WATER AT THE R. C. HARRIS FILTRATION PLANT - RAW & FINISHED WATER (August 27 - November 28, 1980)

Date	Source	PCB	HCB	α- BHC	LINDANE	β- BHC	HEPTACHLOR	HEPT. EPOXIDE	ENDRIN	THIODAN I	THIODAN II	ALDRIN	DIELDRIN	pp DDE	op DDT	pp DDD	pp DDT	α- CHLORDANE	γ- CHLORDANE	MIREX
August 27	raw	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	* .080	X	.005	.002	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
August 28	raw	X	X	.005	X	.001	X	X	.005	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.005	X	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
August 29	raw	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sept. 30	raw																			
	finished	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 1	raw	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 2	raw	X	X	.010	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.100	.001	X	X	.001	X	X	X	X	X	.001	X	X	X	X	X	X
October 3	raw	X	X	.005	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 6	raw	X	X	.005	.005	X	X	X	.005	X	X	X	X	.001	X	X	X	X	X	X
	finished	X	X	.005	.001	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 7	raw	X	X	.005	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.005	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 8	raw	X	X	.005	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.005	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 9	raw	X	X	.010	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.010	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 10	raw	X	X	.010	.001	.010	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.010	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 14	raw	X	X	.010	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.010	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 15	raw	X	X	.005	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.004	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 16	raw	X	X	.005	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.005	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 17	raw	X	X	.006	.001	.004	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.004	X	X	X	X	.005	X	X	X	X	X	X	X	X	X	X	X
October 20	raw	X	X	.004	.001	.002	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.004	.001	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 21	raw	X	X	.004	.002	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.004	.001	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 22	raw	X	X	.005	.001	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.005	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 23	raw	X	X	.005	.002	.002	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.004	.001	X	X	X	X	X	.002	X	X	X	X	X	X	X	X	X
October 24	raw	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	X	X	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Prov. Drinking Water Objective		3	NA	NA	4	NA	3		.2	NA	NA	.7		30				7		NA

X none detected
* sample contamination suspected

TABLE 2A: Cont.

Date	Source	PCB	HCB	α- BHC	LINDANE	β- BHC	HEPTACHLOR	HEPT. EPOXIDE	ENDRIN	THIODAN I	THIODAN II	ALDRIN	DIELDRIN	pp DDE	op DDT	pp DDD	pp DDT	α- CHLORDANE	γ- CHLORDANE	MIREX
October 27	raw	X	X	.006	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.006	.001	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 28	raw	X	X	.005	.001	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.007	.001	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 29	raw	X	X	.006	.001	.003	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.005	.001	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 30	raw	X	X	.006	.001	.003	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.005	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
October 31	raw	X	X	.005	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.004	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
November 3	raw	X	X	.005	.001	X	X	.004	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.006	.001	X	X	.001	X	X	X	X	X	X	X	X	X	X	X	X
November 4	raw	X	X	.005	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.005	.001	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
November 5	raw	X	X	.002	X	X	X	.001	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.003	.001	X	X	.001	X	X	X	X	X	X	X	X	X	X	X	X
November 6	raw	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.005	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
November 7	raw	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
November 10	raw	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
November 12	raw	X	X	.005	.002	.004	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	X	.001	.003	X	X	X	X	X	X	X	X	X	X	X	X	X	X
November 13	raw	X	X	.004	.001	.005	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	.030	X	.003	.001	.005	X	X	X	X	X	X	X	X	X	X	X	X	X	X
November 14	raw	.030	X	.003	.001	.002	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	.020	X	.002	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
November 17	raw	X	X	.008	.002	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	X	X	.002	X	X	X	X	X	X	X	X	X	X	X	X	X	X
November 18	raw	X	X	.001	.001	X	X	.001	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.004	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
November 19	raw	X	X	.004	.001	.002	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.005	.001	.002	X	X	X	X	X	X	X	.004	X	X	X	X	X	X
November 20	raw	X	X	.004	.001	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.005	.001	.002	X	X	X	X	X	X	X	X	X	X	X	X	X	X
November 21	raw	X	X	.005	.001	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.004	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
November 24	raw	X	X	.005	.001	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.014	.011	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
November 25	raw	X	X	.003	.001	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.004	.001	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
November 27	raw	X	X	.003	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	X	.004	.001	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
November 28	raw	X	.004	X	X	.001	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	finished	X	.010	.004	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Prov. Drinking Water Objective		3	NA	NA	4	NA	3		.2	NA	NA	.7		30				7		NA

X none detected
* sample contamination suspected

TABLE 3A: METALS LEVELS (μg/L) IN WATER AT R. C. HARRIS - RAW AND FINISHED WATER

(September 29 - November 28, 1980)

Date	Source	Cr	Pb	Zn	Cu	Al	Total Hg	Cd
Aug. 27	raw						< 0.02	
	finished						< 0.02	
Sept. 29	raw						< 0.03	
	finished						< 0.03	
Sept. 30	raw						< 0.02	
	finished						< 0.02	
Oct. 1	raw						< 0.02	
	finished						< 0.02	
Oct. 2	raw						< 0.03	
	finished						< 0.03	
Oct. 3	raw						< 0.03	
	finished						< 0.03	
Oct. 6	raw						< 0.04	
	finished						< 0.04	
Oct. 7	raw						< 0.02	
	finished						< 0.02	
Oct. 8	raw	3	< 3	5	4	8	< 0.02	0.4
	finished	< 2	4	5	13	39	< 0.02	< 0.2
Oct. 9	raw	< 2	3	9	11	21	< 0.04	0.4
	finished	< 2	< 3	3	6	72	< 0.04	< 0.2
Oct. 10	raw	< 2	4	5	4		< 0.04	0.3
	finished	< 2	< 3	5	2		< 0.04	0.4
Oct. 14	raw	2	5	11	12	20	< 0.04	< 0.2
	finished	< 2	< 3	5	2	39	< 0.04	< 0.2
Oct. 15	raw	< 2	< 3	5	8	31	0.09	0.3
	finished	< 2	< 3	6	2	26	< 0.04	< 0.2
Oct. 16	raw	< 2	< 3	7	6	56	< 0.04	< 0.2
	finished	< 2	< 3	5	8	10	< 0.04	< 0.2
Oct. 17	raw	< 2	< 3	5	6	10	< 0.04	< 0.2
	finished	< 2	< 3	5	3	72	< 0.04	< 0.2
Oct. 20	raw	< 2	< 3	4	4	34	< 0.03	< 0.2
	finished	< 2	< 3	4	2	59	< 0.03	< 0.2
Oct. 21	raw	< 2	< 3	5	5	37	< 0.03	< 0.2
	finished	< 2	< 3	4	2	36	0.03	< 0.2
Oct. 22	raw	< 2	< 3	6	7	< 2	0.07	< 0.2
	finished	< 2	< 3	5	4	< 2	< 0.04	< 0.2
Oct. 23	raw	< 2	< 3	4	3	55	< 0.04	0.3
	finished	< 2	< 3	13	2	65	0.05	< 0.2
Oct. 24	raw	< 2	< 3	7	5	150	< 0.04	< 0.2
	finished	< 2	< 3	3	< 1	68	< 0.04	< 0.2
Oct. 27	raw	< 2	< 3	8	8	48	< 0.03	< 0.2
	finished	< 2	< 3	3	< 1	110	0.03	< 0.2
Oct. 28	raw	< 2	4	3	1	30	< 0.03	< 0.2
	finished	< 2	< 3	6	< 1	33	< 0.03	< 0.2
Oct. 29	raw	< 2	< 4	4	5	21	< 0.03	< 0.2
	finished	< 2	< 3	3	< 1	30	< 0.03	< 0.2
Oct. 30	raw	7	< 3	3	1	20	< 0.03	< 0.2
	finished	< 2	< 3	3	< 1	34	0.06	< 0.2
Oct. 31	raw	< 2	< 3	8	8	47	2.3 *	< 0.2
	finished	< 2	< 3	3	< 1	56	0.04	< 0.2
Prov. Drinking Water Objectives		50	50	5000	1000	NA	1	5